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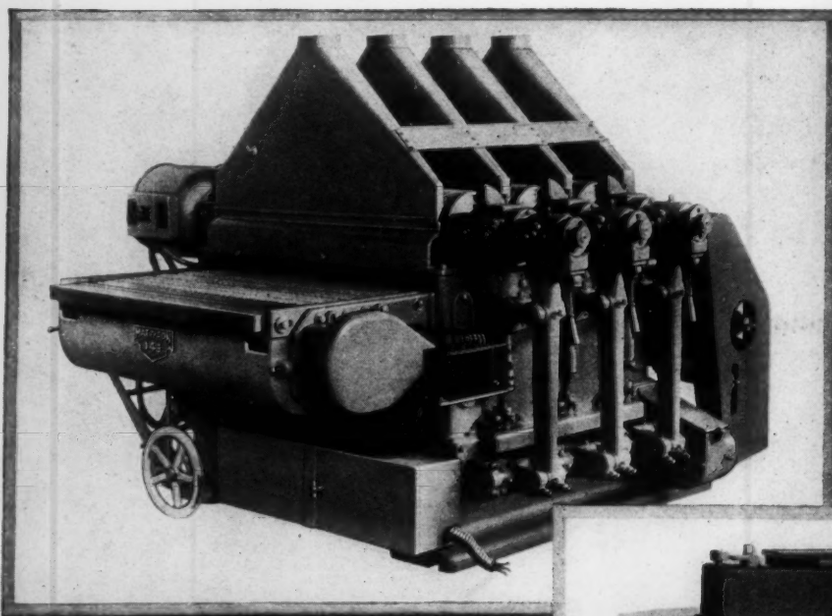
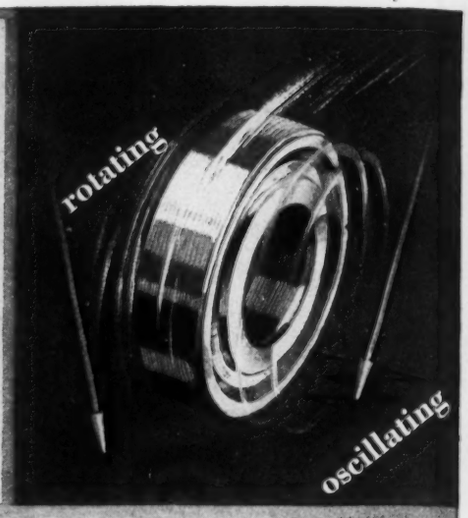
MACHINE DESIGN

AS IT AFFECTS

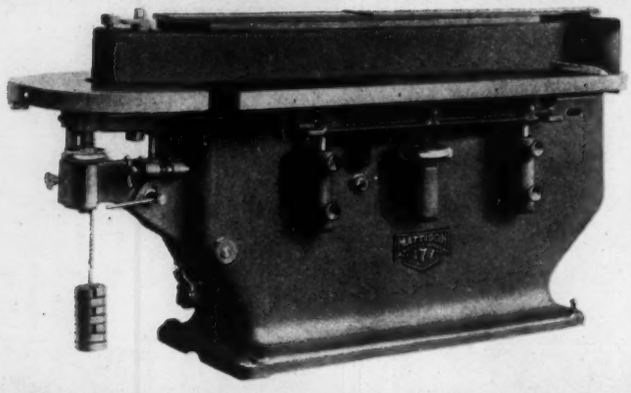
ENGINEERING—PRODUCTION—SALES





1200 r. p. m.

120 endwise oscillations p. m.



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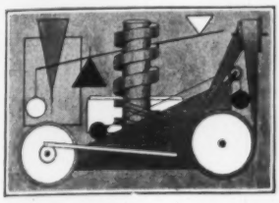
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 3 | August, 1931 | Number 8



In This ISSUE

INTENSE interest was created by "Machinery Salesmans" letter, published last month at the conclusion of the article "Bring Together Sales and Design for Effective Results." Numerous comments were received. Leading members of the design profession rose up en masse in defense of engineering department procedure.

This month the engineers will have their chance. A composite letter covering the high spots of some of the comments received is included in the article commencing on Page 21. It contains numerous references to reasons for misunderstanding between sales and design departments and warrants the close attention of the staffs of each.

L. E. Jermy

Managing Editor

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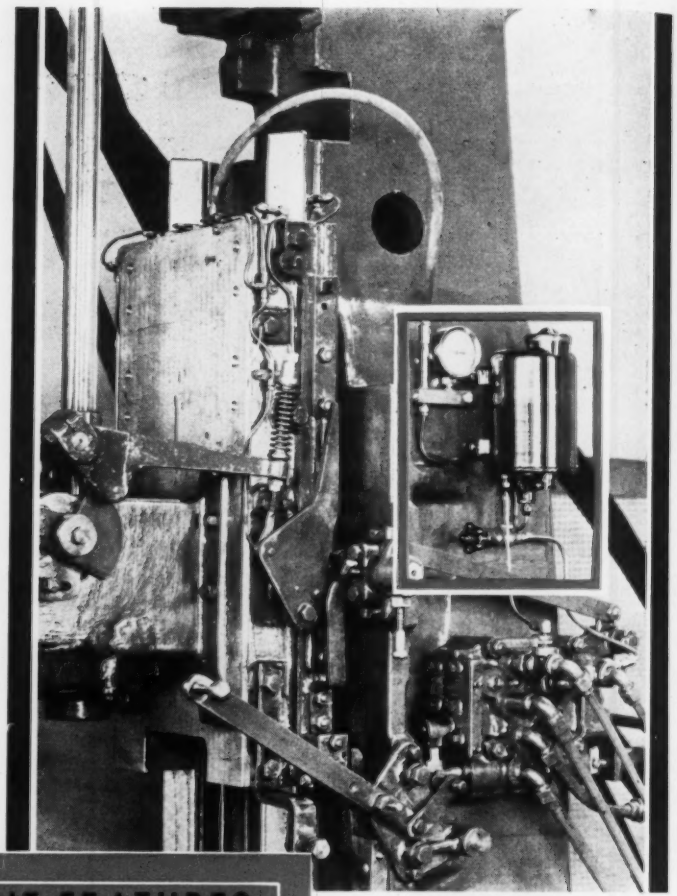

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"IN one of your issues during the past year, I noticed an article on . . . . . Have been trying to locate my copy of the issue containing this but so far have been unable to find it. Will you therefore kindly look this up in your files and send me another copy."

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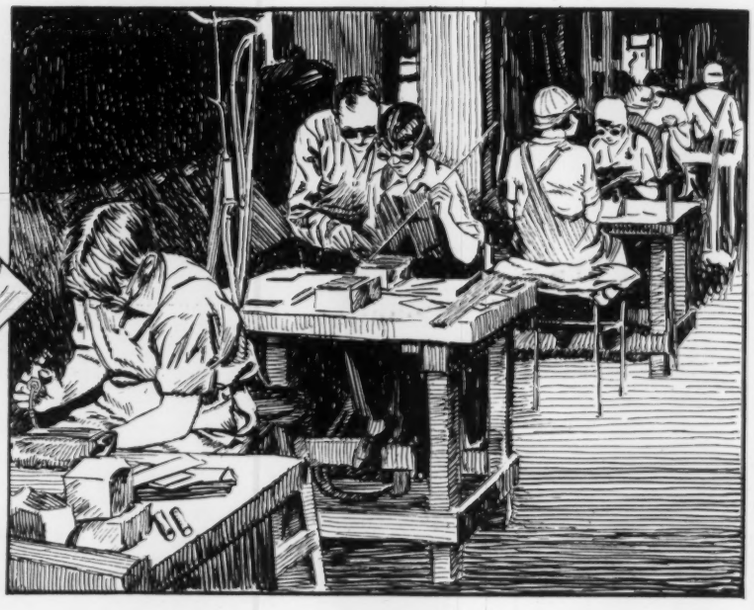
Perhaps you have some question or problem on which we might be of some assistance. If so, don't hesitate to call on us.



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Calendar of Meetings and Expositions

Aug. 10-25—The Industrial Institute. Round table conferences at Silver Bay on Lake George, N. Y. Charles R. Towson, 347 Madison avenue, New York, is secretary.

Aug. 23-29—International Industrial Relations congress. The necessity for planned adjustment of productive capacity and standards of living are the principal topics to be discussed at this meeting at Amsterdam, Holland. Information may be obtained from Miss Mary van Kleeck, Russell Sage Foundation building, New York.

Aug. 25-28—American Institute of Electrical Engineers. The annual Pacific coast meeting of the society to be held at Lake Tahoe, Calif., will include papers on "Electrical Power in Wood Products Industry," by C. E. Carey and K. L. Howe; "Application of Electricity to Oil Field Operation," by H. C. Hill and J. B. Selegue; and "Correlation of Induction Motor Design Factors," by V. Hoover. F. L. Hutchinson, 33 West Thirty-ninth street, New York, is secretary.

Aug. 31-Sept. 4—American Chemical society. Fall meeting at Buffalo, N. Y. Charles L. Parsons, Mills building, Washington, D. C., is secretary.

Sept. 1-3—Society of Automotive Engineers. National aeronautic meeting at Hotel Statler, Cleveland. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

Sept. 2-5—Electrochemical society. Annual meeting at Hotel Utah, Salt Lake City, Utah. Colin G. Fink, Columbia university, New York, is secretary.

Sept. 6-12—International Association for the Testing of Materials. The technical program to be presented at this first international congress to be held at Zurich, Switzerland, has been divided into four groups as follows: Metals; non-metallic inorganic materials; organic materials; and questions of general importance. The papers will include: "The Structure and Mechanical Properties of Cast Iron," by J. G. Pearce; "Tests on Cast Iron," by F. Pisek; "Materials at High Temperatures," by R. G. Batson and H. J. Tapsell; and "The Present State of Knowledge of Fatigue of Metals," by H. J. Gough. Information on the meeting may be obtained from C. L. Warwick, 1315 Spruce street, Philadelphia.

Sept. 7-9—American Society of Mechanical Engineers. Papers to be presented in conjunction with the Southwest power conference at Kansas City, Mo., will include: "A Speed Characteristic for Oil Engines," by V. L. Maleev; "Developments in Internal-Combustion Engines for Use in the Oil Industry," by H. F. Shepherd; "Aircraft Diesel Engines," by H. C. Edwards; and "Flour Milling and Power Requirements," by Grover C. Meyer. Headquarters for the society will be at the Kansas City Athletic club. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

Sept. 7-11—National Association of Power Engineers. Annual meeting and mechanical exposition at convention hall, Kansas City, Mo. Fred W. Raven, 1027 Witherspoon building, Philadelphia, is secretary.

Sept. 12-27—International Foundry Exhibition and Congress. Raw materials, castings and foundry equipment comprise three main groups of the annual exhibition to be held at Milan, Italy. C. Vanzetti, Via Verdi N. 11, Milan, Italy, is chairman of the general executive committee.

Sept. 13-15—British Institute of Metals. Annual autumn meeting at Zurich, Switzerland. G. Shaw Scott, 36 Victoria street, Westminster, London, S. W. 1, is secretary.

Sept. 17—Steel Founders Society of America. First fall meeting to be held at Chicago. Granville P. Rogers, 932 Graybar building, New York, is general manager.

Sept. 21-25—American Welding society. Semiannual meeting in Boston. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary.

Sept. 21-26—American Society for Steel Treating. National Metal congress and exposition to be held at Commonwealth pier and Hotel Statler, Boston. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary.

Sept. 26-Oct. 2—American Electric Railway association. Annual meeting and exposition at Atlantic City. Guy C. Hecker, 292 Madison avenue, New York, is general secretary.

Oct. 12-16—National Safety council. Annual meeting and exposition at Stevens hotel, Chicago. W. H. Cameron, 20 North Wacker drive, Chicago, is secretary.

Oct. 14-16—Society of Industrial Engineers. Annual meeting to be held in Pittsburgh. Geo. C. Dent, 205 W. Wacker drive, Chicago, is secretary.

MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

August, 1931 Vol. 3—No. 8

Bring Together Design and Sales for Effective Results!

By L. E. Jermy

Managing Editor, Machine Design

IN ATTEMPTING to improve relations beween members of the engineering and sales staffs one immediately encounters the great difference in the viewpoints of the two groups. It is almost hopeless to expect full co-operation between the departments unless there is a willingness on both sides to try to understand and evaluate the problems of the other.

Therefore one of the first steps is to analyze the viewpoints of each group. When this is done, it will be found that many of the differences can be reconciled and that there is a bond of common interest which can be used as the basis for a structure of complete understanding.

The wide gulf between the viewpoints of salesmen and engineers is illustrated strikingly in the letters which accompanying this series of articles. The letter by "machinery salesman", in last month's issue, expressing his views of the engineering department, revealed a great enthusiasm for his job, an exaggerated idea of the importance of a certain order, a lack of conception as to the seat of real authority in the home office, a mildly boastful attitude and perhaps a feeling of superiority over engineers.

In this issue, the composite leter by engineers on what they think of the sales department, reveals a suspicion that salesmen are "playboys" whose work enables them to mix in a good measure of recreation with their selling, a conviction that many salesmen try to take advantage of the engineering department and a belief that salesmen do not try very hard to understand the engineer's role—particularly his connection with the problem of delivery dates.

In reviewing these letters, a neutral observer can easily spot the differences of opinion that are due to lack of understanding. It is almost certain that if a sales-

NOTHING that has ever appeared in MACHINE DESIGN has created as much discussion as "What I Think of the Engineering Department" by Machinery Salesmen in last month's issue. Engineers from all parts of the United States and from beyond its borders have risen to the defense of their profession.

Excerpts from their letters have been welded together into a composite—"What Engineers Think of the Sales Department", which begins on the following page. A careful study of the engineering and sales viewpoints, as reflected in this series, will help engineers, salesmen and management to find the key to better co-operation.

—The Editors

man and an engineer could exchange jobs for a month, each would have a new respect for the other. The engineer would find that the salesman's work involves numerous disagreeable tasks which offset the glamor of golf and Pullman smoking room sessions. Likewise the salesman would discover that the engineer daily encounters numerous interruptions, complications, troublesome problems, and an endless chain of petty annoyances which account for his inability to be 100 per cent enthusiastic and cheerful all of the time.

Under conditions wherein the nature of the work is so dissimilar it is not surprising that occasional friction arises. Moreover, it would be unwise—even if it were possible—to change the dominant characteristics of the two types. To take away the self-confidence, buoyant spirit and enthusiasm of the salesman would destroy much of his effectiveness. To deprive the engineer of his passion for correct detail, his ability to choose between fact and fancy, and his cold analytical viewpoint would make him less valuable.

But while the fundamental traits must remain, there is no reason why the two cannot work together harmoniously. The common bond of interest is so strong that it should take precedence over the minor incompatability of temperaments. The desire to do a good job of selling and the desire to do a good job of designing should stand ahead of all other considerations.

The influence of heads of departments has

What Designers Think of the Sales

WE HAVE tried on the shoe that our contemporary salesman-author has made and have found it full of sharp nails which we will attempt to bend over before any harm is done.

In the first place we are sure that engineers in general do not cause trouble deliberately, procrastinate just for the love of it or throw correspondence into the waste basket. Much of the weight of "Machinery Salesman's" charges is lost because he does not understand the conditions under which the engineering department works and because he is confused as to whom is responsible for the situations he so strongly condemns.

For instance, take the case of the 500 machines at $4000, the sale of which was lost because of the mistakes of the engineering department, according to the salesman-critic. Here $2,000,000 of income was involved. If due to negligence—premeditated or otherwise—the engineering department would "sink" such a job, it would surely be a strange organization indeed in which the executives would sit idly by and hear the engineers "laugh it off." We suspect that this particular deal was exaggerated, as are many salesmen's deals. It is quite easy to get the decimal point in the wrong place.

"Is it possible?"

In the matter of delivery dates, which is such a very sore point with our critic, it is only logical and reasonable to expect a competent salesman to communicate with the management and ascertain a shipping date before making a promise to the customer. Promises of delivery made without reference to the facts of the case naturally are impossible to carry out.

In this connection, engineers often are told that "time is the essence of the contract." What a fallacy where engineering design work is involved! We know of no machine built from original design drawings or sketches that was a success in every respect. Changes in details, at least, become advisable as work progresses in the shop. A new machine running successfully, apparently, on the testing floor may be found to develop weaknesses after a few months in actual service. Time only proves a design. And yet it is not uncommon for a sales manager to guarantee a newly designed machine to operate satisfactorily for three years! This is on his own initiative. It sometimes is necessary in order to land the contract.

In our opinion the salesman who is willing to assume credit for all the successes in a new sale but who washes his hands of any delivery delays is a short sport. If the design department shows hesitancy in time promises the sales department should be just as hesitant with the customer.

We fully appreciate the seriousness of the problem of promised delivery dates. But we submit that the salesmen share the responsibility with the engineering and works staffs. A better appreciation on the part of salesmen as to what is involved in keeping a delivery promise would inspire better co-operation. A sales department which habitually makes promises that even the office boy knows are impossible is a destructive influence on the morale of the engineering and shop forces.

One of the troubles in any organization is that all departments cannot see alike on the same order. To the salesman who lands it, it is the biggest thing before the company. It the executives, engineers and shop personnel do not share his enthusiasm, he thinks he is being "let down."

Sometimes a salesman overestimates the importance of his particular order. He expects the factory to "hold everything" and give its entire attention to his particular client. When an order is received that requires modification from the standard line it at once becomes subject to a chain of circumstances requiring new drawings, pattern changes, improved shop methods, credit investigation, executive approval, etc. In a case of this kind the entire organization must put its shoulder to the wheel

a great deal to do with the attitude of the men in the departments. When a sales manager has full confidence in the design department, that confidence usually spreads to all of the salesmen. When you hear a sales representative telling a customer that his designers are the "best in the business," you know that the relations between the sales and engineering staffs are satisfactory. The same holds true for the engineering personnel. When the chief engineer respects the sales manager, that esteem usually is contagious throughout the engineering force.

Therefore it is important that the basis of mutual understanding, confidence and respect begin at the top. Insure the proper relationship between the chiefs and the attitude of workers down the line will in most cases take care of itself.

This brings us to one of the most important factors in the problem of co-operation in sales and design. It is the attitude of the management toward the two departments. If the executives habitually favor one over the other there is bound to be trouble, no matter how faithful or how capable are the men in the neglected department.

Unfortunately the chief executive is more apt to lean toward the sales department than toward the design department. One reason is that sales problems involve more elements of a business nature than engineering problems. Another is that the average sales manager can "sell" his department to the president of the

---

Department—By a Group of Engineers

and in case of a fall-down, the blame should not be borne alone by the engineering department.

Many engineers, after years of experience in dealing with members of sales departments, are forced by that experience to discount the apparent anxiety of certain salesmen over delivery dates. Here is an illustration, as repeatedly, get used to it and it is only natural that they 'I have a dozen telegrams on that X. Y. Z. job. What can I tell them?' In reply I said, 'Let me see the telegrams.' Then he sheepishly admitted that there were no telegrams, but exhibited a follow-up form letter."

Engineers who are exposed to this cry of "Wolf, wolf" repeatedly get used to it and it is only natural that they develop a seeming loss of interest in certain cases. This problem is one in which each salesman bears a direct responsibility. Those who deal fairly with the engineering department usually can expect and certainly should receive the utmost in co-operation, while those who habitually try to "put over a fast one" should not be surprised if gradually the engineering department loses interest in their cases.

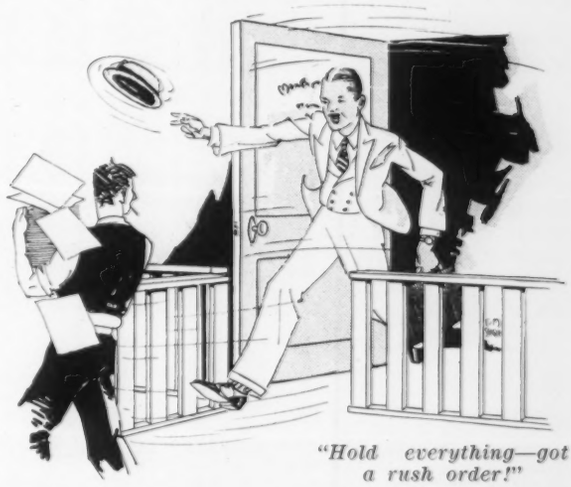
As for procrastination, there is a tendency for engineers to indulge in this trait, which is common to members of all trades and professions. Among engineers some of it should and could be eliminated.

But let us not forget that the engineer suffers from procrastination in other departments. In more than one case design departments have worked night and day to create a new model, only to see the drawings shelved indefinitely. Then suddenly, without warning, they are brought forth and another siege of night work ensues while revisions are made. A certain amount of this delay is inevitable but much of it could be avoided by better management.

It is also true that many engineers stick too closely to the drawing boards and desks. This is especially true among draftsmen and designers. The general engineer gets out more frequently and in most cases enjoys a broader viewpoint. However, it is not fair to criticize the stay-at-homes too harshly, since the attitude of the management controls their freedom or lack of it to make trips into the field.

Most engineers have an individual desire to get out and look at their creations in actual service. One designer took part of his vacation to visit a plant where a machine designed by him was in operation. On returning to work after his vacation he was told that the sales department had resented his visit.

"Machinery Salesman" charges that engineers do not



"Hold everything—got a rush order!"

take kindly to suggestions and advice from the sales department. There undoubtedly is a tendency among some engineers to resent suggestions from the field, but the great majority are open to advice and constructive criticism if it is presented in the right way. It should be remembered however that there is no profession or class of workers that hears and sees more half-baked ideas and freak suggestions and is subjected to more criticism than the mechanical engineers. In a great measure the success of an engineer depends upon his ability to pick out the good from the bad.

Everyone should agree that information from the field is highly desirable and it goes without saying that salesmen are in a fine position to gather this information and

(Concluded on Following Page)

company more convincingly than the average chief engineer.

In this respect the head of the engineering department owes it to himself and to his staff to make every effort to see that the importance of engineering is recognized in the company policy. In many cases the engineering side of the business does not assume its rightful place in the company's activities because the head engineer refuses to contribute his share of advice and counsel in discussions of executive policy. The chief engineer must make himself a useful member of the executive family if his department is to secure proper executive support.

Of course there are many instances where executive blindness deprives the engineer from taking part in the formation of company policies. When this situation exists, the president is at fault in that he is shirking management's responsibility for design. The immediate responsibility for design lies with the head of the engineering department, but when this department is overruled by the management—either through deliberate intent, neglect or misunderstanding—then the responsibility for design passes to the management.

Because more designs go wrong through bad management than through poor engineering, and because lapses in executive direction are as much responsible for lack of harmony in design and sales effort as any other single factor, the subject of management's responsibility for design will be discussed in detail in an early article in this series.

What Designers Think of the Sales Department

(Concluded from Preceding Page)

transmit it to the proper offices. But not all members of the selling fraternity take full advantage of their opportunities. Frequently they display a tendency to view the things they see superficially and do not get the important detail. When field salesmen send in complete reports, containing the kind of information that is valuable to the engineering department in its design work, then the salesmen should expect that their efforts will be gratefully received. Moreover engineers should and in most cases do welcome this kind of co-operation.

"I told him where to get off at!"

We agree wholeheartedly that engineers should welcome ideas from the sales force, but in the same breath we ask that the sales representatives use discretion in presenting suggestions.

For instance, when the sales manager or district salesman brings a customer with a suggested improvement into the engineering department, it would be the courteous thing for the salesman to introduce the engineer to the customer. Frequently, with crass discourtesy, the salesman omits this formality and proceeds to explain the design in an extravagant manner—almost igoring the man who created the design. Engineers are not unduly sensitive, but they naturally resent action of this kind, which connotes distrust. It would seem that it is the role of the sales force to "sell" customers the ideas that the engineering staff is competent. This cannot be done if sales representatives try to trample engineers under foot in the presence of customers.

In the matter of correspondence, we believe engineers in the majority of cases are very careful to reply to all letters that require replies and in many cases to those wherein no answer is really called for. It would seem that "Machinery Salesman" has been rubbing his engineering department the wrong way, both from the standpoint of the way in which his correspondence was treated and the suggestions when he came back from a trip on the road. The engineer has a spirit of co-operation, which if properly cultivated by the salesman, would not result in the conditions that apparently exist in this case.

Just a word about the salesman as he returns from a trip. Pity him. In he comes with a fine coat of tan. If we give him the attention that he thinks he deserves we would have to listen to a few. "Here's a new one, etc,", visualize about 18 holes of golf with all its hazards, picture the distress of many traffic cops who were told where they got off, put down statistics on the increase of bum drivers on the road—and by that time it would be 5 p.m. and we would be asked if we expect to be in early the next day as there is some dope that he wants.

If salesmen would exercise as much diplomacy in dealing with engineers as they display in inducing the customer to sign on the dotted line there would be fewer misunderstandings. Get acquainted with the engineer. You will find that he is intelligent, even though he sometimes is handicapped in selling himself or his idea, has good judgment and can make good decisions. And above all do not try to "high-hat" him, because in nine cases out of ten, he can see through you like a sieve.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Design Solves Vibration Problem

VIBRATION has been one of the designer's keenest problems to which a great deal of ingenuity has and still is being applied. Mountings of automobile engines have afforded an important field for new ideas in this direction and various means have been devised for checking vibration. The latest method developed is being used in the new model Plymouth automobile to prevent transmission of engine vibration to the chassis.

The arrangement used in this case consists of a two-point rubber mounting with one support placed high at the front of the engine and the other at the rear of the transmission to provide what is termed "floating power." To preserve the proper alignment of the engine and to hold its movement within the limits allowed by the rubber mountings, a built-up cantilever stabilizing spring is used between the rear of engine and the frame side member. The built-up end of this spring is attached rigidly to the engine and the other end is embedded in rubber in the frame side member. The points of suspension and the spring are shown in Fig. 2.

Rubber mountings for automobile engines are not new. However, engineers of the Chrysler Corp. employed an idea in connection with this type of mounting which is quite interesting. When former mountings proved the impracticability of providing enough internal friction and enough flexibility together with strength to prevent completely the transmission of engine vibration to the frame, it was decided to mount the engine on an axis containing the center of gravity.

Referring to Fig. 1, it will be seen where this axis lies in the Plymouth engine. The rear support had to be located near the center line of the extension from the power plant in order to hold this point constant. After the center of gravity was determined and a straight line drawn from the rear support through the center of gravity, the point for front support was located readily. It would lie some place along this axis, in the case of the Plymouth at the fan-shaft.

Rubber is used in both front and rear supports and the stabilizer spring is sufficiently flexible to permit whatever motion the engine would go through under torque reaction variations without transmitting these movements of impulses to the frame. Engine movements, while actually no less than in normal designs, are not carried

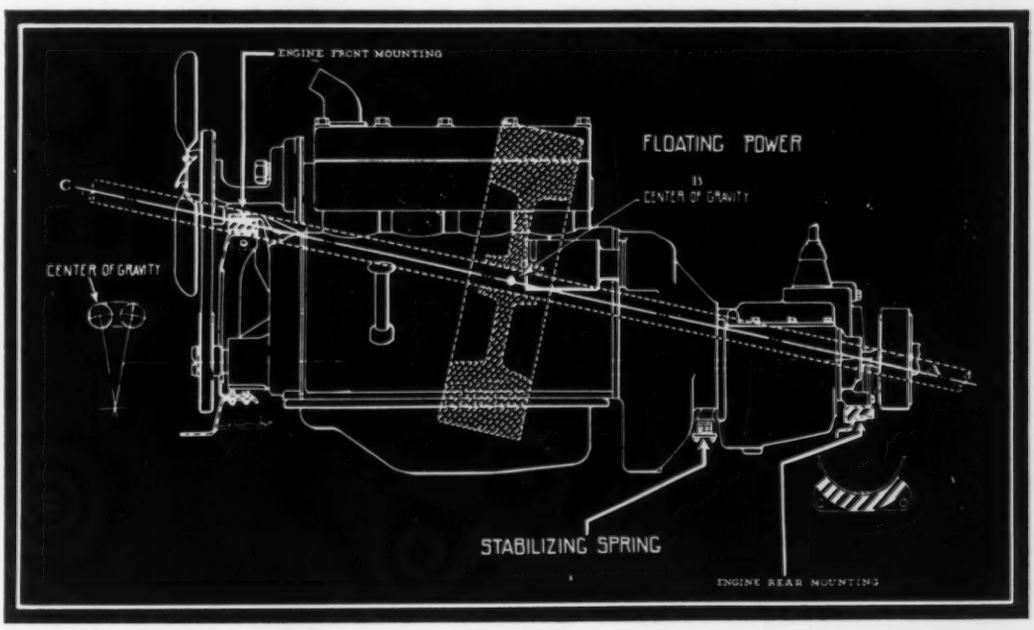


Fig. 1—Axis shown in diagram of the Plymouth engine passes from rear support through center of gravity, determining height of front mounting. Rubber is used at the points of suspension as well as a stabilizing spring to prevent transference of engine vibration to chassis

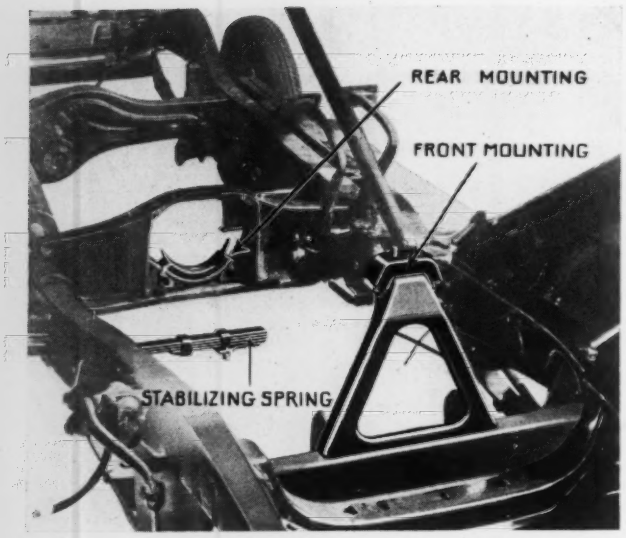


Fig. 2—Positions of engine supports and stabilizing spring

over into the frame in the form of synchronous vibration. To make the use of the "floating power" mounting fully effective, the control mechanisms, such as the clutch and brake pedals, have been disassociated from the engine and are carried on the frame.

Other new developments in the automotive industry include a dash controlled shock absorber device with three stages to enhance the comfort of riding. This unit is shown in Fig. 3, and is being used on Packard eights. Dodge house-to-house delivery vehicles are being equipped with an ingeniously devised spring which brings the brakes into action when the clutch is released. Danger of overheated brakes and tires on motor cars and trucks is reduced to a minimum by a new "air blast" brake drum which has been perfected by the Gunite Corp., Rockford, Ill. Radial ribs or fins cast to the inside back face of the brake drum are covered with a thin plate, forming a centrifugal fan that draws in cool air through small holes at its smallest diameter and blows it between the drum and lining, over the shoes and upon the tires.

Utilizing Photoelectric Relays

WHAT will be the next application of photoelectric cells? That question doubtlessly will be answered before this has long been in print, so rapidly are these versatile units being employed in connection with various machines. Going back through previous issues of MACHINE DESIGN it will be found that the photoelectric cell or "electric eye" as it often is called, has commanded a great deal of attention. Other new uses have come to the forefront, which give further proof of its increasing importance in design.

These new applications described in the following paragraphs may suggest other ideas for control through photoelectric relays. Of the recent installations, one of the most unusual is the use of these relays and a monorail conveyor system to speed mail handling in a railroad terminal. The Cleveland Electric Tramrail division of Cleveland Crane & Mfg. Co. and General Electric Co. have co-operated in devising a system in which each mail bag is placed on a separate carrier and distributed automatically among the railroad cars traveling to various cities to which the mail is addressed.

To accomplish this the photoelectric tube provides the "brains," being mounted on a slide forming the selector station with stops for 17 positions. The selector station with the cell mounted on the slide is shown in Fig. 4. As the carriers pass the dispatcher (Fig. 5), he looks at the tag on the mail sack and adjusts the selector arm to the proper station. Speed of the carrier at this point is timed so as to permit the operator to adjust the selector bar without stopping the conveyor.

As the conveyor passes station No. 1, the first floor carrier being set for that point, the focus-

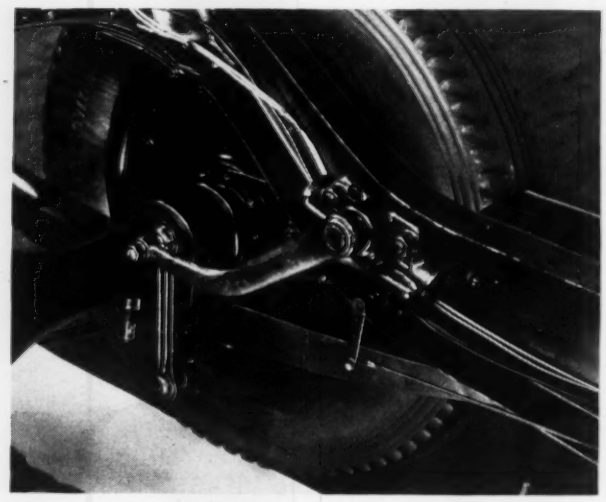


Fig. 3—Three-stage shock absorber controlled from dash

ing light source throws its beam on the photoelectric tube which in turn operates the relay and tripping mechanism, dumping the sack into the mail chute, down which it slides to the mail car. A similar operation takes place when the other carriers arrive at their corresponding stations. After the trays have been tripped and unloaded they are returned on the looped tramrail.

Synchronizing rubber conveyors by thyratron tubes is being accomplished successfully by the B. F. Goodrich Co. While this type of tube differs from the photoelectric cell it comes in the category of electronic equipment and its use with another type of conveyor will be particularly pertinent in connection with the description of the mail handling arrangement.

This is an example where manual control has

been supplanted by electrical equipment, the former having been found unsatisfactory in controlling speeds of conveyors used in processing work. By the arrangement, the first conveyor, or the one receiving material is driven at a fixed rate of speed depending on the material in question, and the other conveyors are synchronized with this key conveyor. The material, in strip form, dips slightly as it passes from one conveyor to another. In each of these dips rides a wheel attached to a balanced lever mechanism. The lever mechanism, at its other end, governs the movement of a core in a reactor. Variations, in the reactance of the reactor (governed by the position of the core which changes according to the rider wheel) control the output voltage of a pair of thyratrons in the circuit of the motor driving each conveyor. When a conveyor is running too fast for the preceding one the slack between them tightens and raises the rider wheel, thus effecting synchronism.

Fig. 5—Dispatcher reading tag on mail bag and setting routing mechanism as mail travels by a conveyor

Still another use for photoelectric cells is in a recording color analyzer which has been found valuable in nearly every branch of industry in which control of color is necessary. Accurate color measurement is a first consideration in textiles, particularly in delicate shades which often deceive the eye. Color control also is of basic importance in making inks, paints, dyes and paper. In this connection it also is interesting to note that A. H. Pfund, professor of physics, Johns Hopkins university, has utilized the photoelectric cell in the development of a precision cryptometer to measure the hiding power of paint.

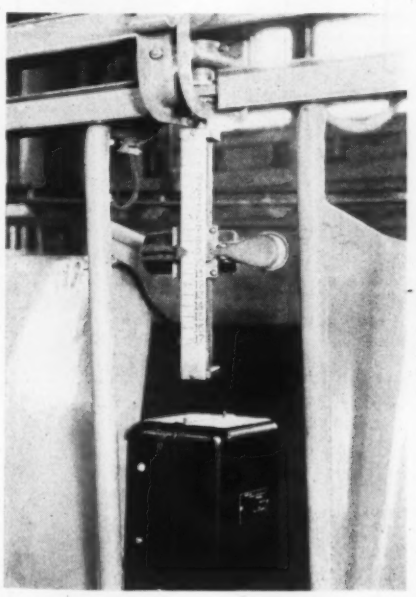


Fig. 4 — View showing closeup of selector bar which is marked for 17 stations. The box contains the photoelectric relay equipment

Opportunities in Domestic Field

WELDING is strengthening the position of steel as a material for house frames and with the increase of steel houses no doubt will come a demand for machinery to aid contractors in constructing them. Welding equipment already has undergone much development in the past few years, due primarily to the greater application of this means of joining metals.

The designer will profit by watching this field as a promising prospect for his ideas. With a potential market for almost 3,000,000 tons of steel annually suggested by this type of home there is a certainty that steel manufacurers will promote their use. Designers of metalworking machinery particularly will be called upon to provide new equipment in this industry.

Influence of the age of machinery on the home is further impressed by the large use of electricity for operation of many types of domestic machines. Steinmetz said the electrical age is yet to come. Power companies have begun to recognize the opportunity of offering correspondingly low rates for current to be used in a new system of house heating if the current is consumed only when electrical rush hours do not prevail.

The system of storing heated water to keep the home warm in winter utilizes a by-product of electrical companies—idle hour electricity. It uses electrical power only when needed without waste of heat yielding elements or consumer's money. Thus it would appear that the era of electricity for homes and buildings has begun and that it will expand in proportion to the action of

individual power companies in establishing a low off-peak rate, and in the ability of engineers to seize the opportunity afforded in development of equipment for the household field.

Tools Revolve, Work Is Stationary

DEVELOPMENTS in metalworking machines are proceeding apace, bringing to the engineering department facilities for permitting improvements in design at reduced production costs. The milling machines described on page 45 of this issue bear witness of this. Another example is the heavy type crankshaft lathe developed by Schiess-Defries, Dusseldorf, Germany, shown in Fig. 6.

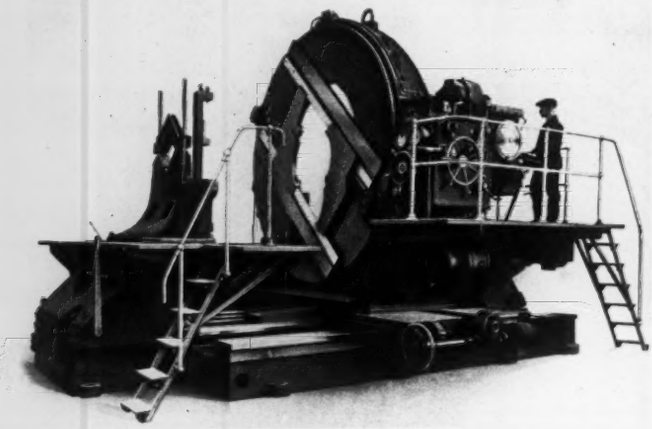


Fig. 6—Work is held stationary while the tools revolve on this crankshaft lathe

In this new unit the work remains stationary while the tools revolve. Turning of crankshafts, particularly, because of their weight and magnitude have made old methods impractical. Simple clamping devices are employed and less strain on the machine and operator ensues. The steady for supporting the crankshaft is adjustable.

Rail Car Designed for Propeller

PROPULSION of land and air vehicles long has attracted the attention of engineers. Various modes have been tried and among these is a propeller drive for a rail car which recently underwent tests in Germany. The body of the car is streamlined, with a 500-horsepower airplane engine installed in the rear to drive a four-blade propeller. The car, which has been under development for 15 years, attained a speed of 124 miles an hour over a straight track. Herr Kruckenberg, the designer, estimates the maximum speed as 185 miles an hour.

Of interest in this connection are the experiments of Hiram S. Maxim at his Baldwin Park laboratory in England in 1892. *Research Narratives* of the Engineering Foundation tell of his flying machine which he sought to build using steam for the engine. The machine, during experiments, was about ten feet square with wheels designed to run on rails. The experiments proved that it was possible for propellers to get a grip on air, dispelling an old belief that such was not feasible.

Reducing Weight With Aluminum

NEW industrial requirements have emphasized the fact that weight must be saved in the design of modern machinery. To accomplish this designers are turning to the advantages of such materials as aluminum alloys. One instance where a machinery manufacturer has employed it advantageously is the Marion Steam Shovel Co. which recently designed an aluminum alloy boom for one of its giant dragline excavators. As aluminum alloy weighs about 1/3 as much as steel, it was possible to build a boom of this material to weigh less than one-half that of a steel structure of equivalent length and strength. Fig. 7 shows the comparative size of the boom which required four flat cars to transport it.

Of importance in excavator design is the yardage capacity and from this standpoint a unit with an aluminum alloy boom can be built with the same working weight and range as one with a steel boom, but having much larger bucket capacity and therefore capable of greater yardage without increase in gross power or labor expense.

Aluminum also is being used for pullman cars on railroad trains as a means of reducing weight. A saving of 25 to 40 per cent is estimated.

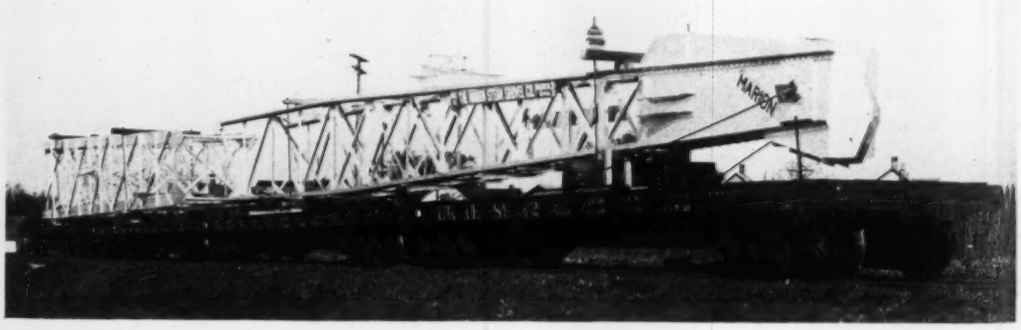


Fig. 7—Aluminum alloy was used for this big excavator boom to reduce weight. An idea of its size is given by the fact that it took four flat cars to transport it

Post and Gatty Use Supercharger

By V. I. Moncrieff

LIKE all Pratt and Whitney engines, the recent record-breaking 'round-the-world Wasp installed in the plane flown by Post and Gatty incorporates a supercharger in its design. The supercharger serves the two-fold purpose of improving distribution to each of the nine cylinders and of providing a means to increase the pressure behind the gas charge to the cylinders.

Referring to Fig. 1 the carburetor is attached below a curved intake extending from "A", and the impeller "B" (having numerous blades "B'") draws mixture up the elbow and forces it through passages "C" into annulus "D" from which each cylinder receives a charge through individual intake pipes "E". The passages "C" have a pronounced curvature so as to take gas tangentially from the impeller.

The tail end of crankshaft "G" projects through the rear crankcase wall "F" and has keyed to it gear "H" which meshes with gear "N" for the starter and generator drive, and two other gears (not shown) for the magneto drives. Inside of gear "H" is a steel and bronze plate friction clutch whose driven member engages the ends of teeth of floating gear "J". The drive is across to "K", into "L" and across to "M" impeller shaft, which is on the center line of engine. Blower ratios up to 14:1 can be supplied, the ratio depending on the service for which engine is intended.

The clutch is set to a definite torque, depending on blower ratio, engine displacement, and revolutions per minute of engine. During rapid acceleration the clutch slips sufficiently to protect the blower gearing and bearings from excessive forces, and it likewise prevents crankshaft torsional vibration from reaching the blower drive.

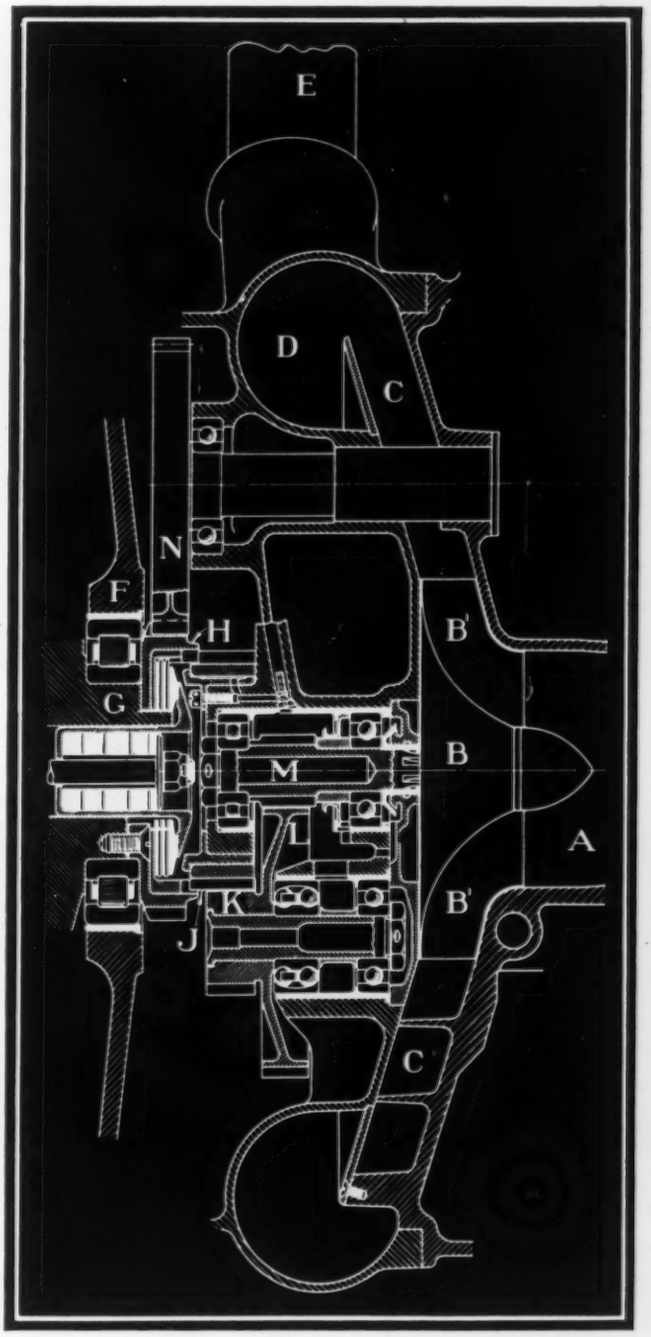


Fig. 1—Cross section of unit showing clutch, bearing mountings and lubricant seals

When it is considered that the impeller in a high ratio blower may reach 40,000 revolutions per minute at times, the importance of smoothness can be appreciated. Impellers are dural (forged), so as to reduce kinetic energy to a minimum, and are very carefully balanced. In high speed mechanisms of this sort rigidity of mounting and ample bearings are highly essen-

tial. A two-piece internally splined steel hub, each flanged at one end, is used for the impeller. These sections are pressed in from each side of the impeller and substantial countersunk head rivets hold the dural tightly between the hub flanges. The steel hub material for the splines is two to three times harder than dural.

Blade Breakage Almost Non-Existant

Impellers have twelve or sixteen blades to handle the gas efficiently, and the tips at the entrance end are curled over to help the entrance conditions. Metal is scalloped out between the blades at the closed side as required for dynamic balance. While the blades are only approximately 1/32-inch thick at tips and 1/8-inch at roots, blade breakage is rare and almost always is the result of the entrance of some foreign object through the carburetor. This possibility is much reduced by the use of an air inlet screen.

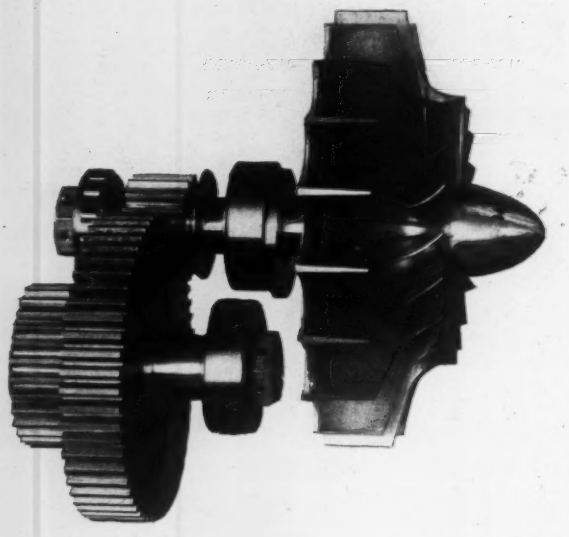


Fig. 2—Geared-up impeller occasionally reaches speed of 40,000 R. P. M.

A feature of general interest is the oil supply. This provides pressure to the floating gear "J," a metered supply directly above pinion "M", and jet supply (not shown) to the points of mesh. Close running fits, slingers, and drained oil grooves prevent oil from working out to the high speed impeller. Since oil consumption of the engine is limited to .035 pounds per horsepower hour, waste at any point is to be avoided, and means for preventing leaks have been highly developed.

A shaft sleeve immediately behind the pinion (to right of pinion on drawing) runs in a housing gland with 0.006-inch clearance. Most of the oil that gets by this first seal is slung off as it comes through and drains out through a hole in the bottom of steel cage. The next oil stop is a drained slinger to the rear of the last bearing, the slinger hub passing through the anchor plate boss with 0.003-inch clearance to complete the seal. Throughout the engine oil leakage is prevented by joints having smooth surfaces and accurate fits. Gaskets are used at a number of places where the heat is not too great. They are not employed between the two halves of the engine crankcase or where cylinders are joined to it. Oil leakage in the latter case is prevented by lapping the cylinder bases and machining the crankcase pads with a circular facing cut.

The technical points involved in supercharging are many and complex. In simple terms, the power output of an engine is proportional to the mean effective pressure developed in the cylinder. This pressure could be greatly increased over present practice if fuel were not subject to detonation at high compression pressures. (A corollary of this point is the fact that, up to the detonation point, a high compression cylinder will run cooler than one of low compression of same power output, because of its greater cycle efficiency.) Compression pressure is a product of compression ratio and manifold pressure that fills the cylinder.

Charge Increases with Engine Speed

At low speeds the Wasp manifold pressure is negative; at higher speeds it crosses over to positive pressure and increases with increase in engine revolutions per minute. With suction-filled engines the power increase keeps in step with increasing engine revolutions per minute up to the point where inlet valves begin to choke on the increasing demands of the cylinder for more gas. In supercharged engines, however, gas is forced into the cylinder under increasing pressure as the engine revolutions per minute increase, and the inlet valve continues to satisfy fully the demands of the cylinder for gas and more gas.

By employing a high degree of supercharging, the mean effective pressure and horsepower of the engine are increased enormously at sea level for short periods but cannot be held long due to detonation of fuel under the extreme compression pressures. At 8000 or 10,000 feet altitude the same engine will deliver less power than at sea level—but this high altitude power will be full rated Wasp power. If, then, the obviously incorrect sea level condition is corrected by applying stops to the throttle to limit the engine to rated power, we have an engine capable of developing full power from sea level to 10,000 feet with a large power reserve at sea level available in emergencies by jumping the throttle stops.

Determining Results of Abuse in Advance

By
R. G. Roshong & U. A. Whitaker

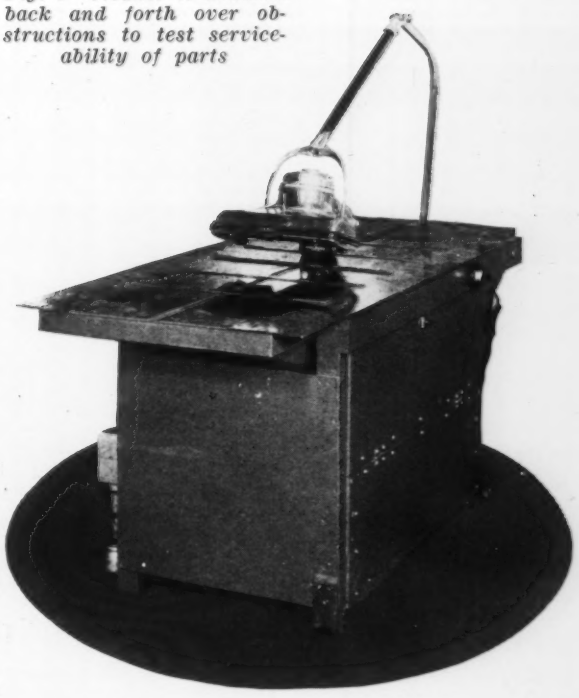
IN RECENT years the pressure on the designer to reduce weight has made the use of careful tests necessary if the quality of the product is to be improved or even maintained. Insistence of present day managements that improvements in design be taken advantage of as quickly as possible makes it desirable that test results be obtained in a shorter time than they could be secured by field or service tests. As a result it is necessary to depend largely on the data obtained from accelerated tests for preliminary design work.

The extent to which the use of tests in connection with design are required depends on the nature of the product. The designer of an ordinary bridge or building frame work might make a satisfactory and dependable design without tests to check his calculations, but no amount of calculation would enable a designer to determine accurately how long the wheels of an electric cleaner or the switch of a washing machine would last in actual service.

By carrying accurate accelerated tests along, practically parallel with design, it is possible to make corrections and alterations as the design proceeds. This avoids the disheartening result that otherwise is likely to be experienced, of finding that some one major part of the machine is so far wrong that the entire design must be scrapped.

DESIGN benefits by accelerated testing. There is hardly a machine that could not be improved by advance determination of results of service. In the accompanying article is detailed some of the intensive and extensive procedure followed by The Hoover Co. in the design of vacuum cleaners.

Fig. 1—Cleaner is bounced back and forth over obstructions to test serviceability of parts



Tests that are made on various parts of the machine during the process of design usually may be carried out on more or less crude models, the idea being to prove only that the design is fundamentally correct. When the design is complete, however, additional tests must be made on complete machines made in accordance with detail drawings. These machines should be made as nearly as possible by the same methods as would be used in producing the machines in production, and the proper dimensional tolerances should be used. Tests on these complete machines will not only check the design but also will bring out many little manufacturing difficulties that otherwise would not be found until release of the machine for production.

Procedure Used in Testing Cleaners

Nearly all parts of the Hoover cleaner, including motors, are designed and manufactured within the company. A few parts such as precision ball bearings, Bakelite and rubber goods, on account of the specialized equipment and manufacturing technique required, are purchased from outside sources. Whether purchased or manufactured within the plant, all

fabricated parts are subjected to tests and are required to meet performance specifications. Raw material tests also are carried out.

Complete experimental motors are constructed to determine probable brush, commutator and bearing life. Overspeed tests are made at 1½ times normal speed to check the design calculations as to factors of safety in the commutator and armature. These tests also bring out such characteristics as undesirable motor noises and vibrations.

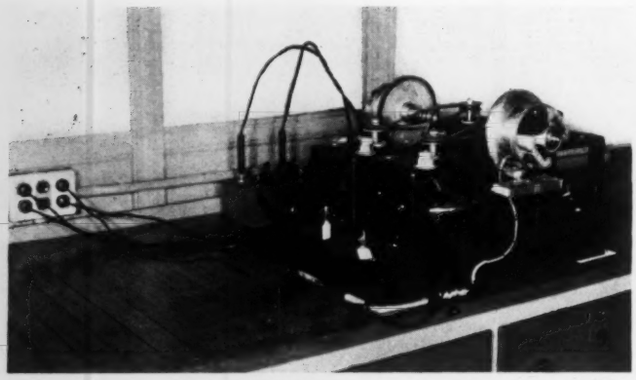


Fig. 2—Electrical eddy current brake for testing rubber belts

The agitator and proper mountings are subjected to severe bumping action by mechanically operating a cleaner at normal speed over steel obstructions ¼-inch high (Fig. 1). As the cleaner passes over these obstructions the agitator is subjected to impact when the beater bars contact with the obstruction. This action, throwing the cleaner intermittently a considerable distance from the floor level, causes unusual stresses on the agitator bearings, beater bars, agitator shell and mountings. The test duplicates the action obtained in actual service when the agitator accidentally strikes hard objects such as in passing over door sills, floor registers or in striking other objects protruding from the floor. Each test cleaner is required to withstand this test for a predetermined number of cycles.

Material Changed as Result of Test

Accelerated tests are particularly useful in determining whether substitutions can be made in the material required for a certain part. A good illustration of this is the adoption of heat treated aluminum sheet to replace steel in the construction of motor caps, as a result of permanent deformation tests which were made on completed caps of various materials. A simple impact machine was designed in which a 2½-pound weight with a spherical indentor is dropped on the cap from various heights and the depth of the indentation measured. These tests showed that caps made of heat treated aluminum stock were capable of withstanding impacts at least three times as great as would be met with in actual service and were nearly equal to a deep drawing steel of the same thickness, with a decrease of 66 per cent in weight for this particular part as compared to steel.

Litter Is Passed Through Cleaner

To insure that any particles which the cleaner is likely to pick up in service will not damage the parts with which it comes in contact in the air passages, from the cleaner to the bag, the cleaner is subjected to what is known as hard litter tests. This consists of passing such articles as nails, coins, carpet tacks, hairpins, and small pebbles through the cleaner and then examining the effect such action may have on various parts contacted. This test is of use in determining the material and sections to be used for such items as beater bars, agitator assemblies, fans and fan chambers.

In addition to the hard litter tests, other materials such as Kapok, string, needles, hairpins and hair are passed through the cleaner to determine if the air passages are likely to become clogged by soft surface litter. With the information resulting from these tests it usually is comparatively easy to make such modifications as may be desirable.

It is, of course, necessary to protect such parts as motor and agitator ball bearings from coming in actual contact with the dirt handled in sweeping. Dirt of such character as found in rugs therefore is passed through the cleaner at a uniform rate for a given length of time as indicated in Fig. 5, and observations made for the presence of dirt in the parts tested. In localities where sandy soil exists, the dirt passing

Fig. 3—Fan characteristics are studied by means of small dynamometer

through the cleaner may erode certain parts. Test cleaners are subjected to a sand erosion test to insure that they will meet this condition. Sand of 65-100 mesh is passed through the cleaner at the rate of 40 pounds per hour and the action on fans and fan chambers of the various materials is observed at regular intervals. To cope with conditions of severe erosion the fan chambers are lined with special abrasion resistant materials.

In determining the effects of careless handling of the cleaner a test has been devised which is known as the collision test, in which an attempt has been made to simulate the action obtainable by ramming a cleaner into furniture and radiators. The complete cleaner is allowed to roll down an incline at a speed far in excess of operating speed and permitted to collide with a rigidly mounted steel block at the bottom of the incline. The point of contact with the block is made midway between the top and bottom of the motor casing. The impact tends to stress various motor parts such as the bearing supports, armature shaft and motor case mounting. After a definite number of collisions the motor is examined for a running balance and evidence of excessive vibration and noise.

So far it has been found almost impractical to make accelerated tests on such an item as a ball bearing. In order to evaluate the relative merits of competitive ball bearings used in the motor and agitator, the bearings are placed on an intermittent running test in which the cleaner is operated at normal loading for a period of five minutes and remains idle for two minutes. Aural examinations are made twice a day to determine if the bearing has developed undesirable noise and the test is allowed to proceed to 1000 hours if the bearing is still operating satisfactorily. At the end of this period another aural examination is made in comparison with a new motor and other motors having competitive bearings, which have been operated for a similar length of time. The bearing also is dissembled and examined under a low power microscope, for evidence of pitting and wear in the ball separators and races. By making a comparison of the results after the 1000 hour running period it becomes relatively easy for an experienced observer to predict the possible life of the bearings tested. In making the above tests, considerable attention is given to the matter of greasing the bearings. Each bearing is supplied with the same type and amount of grease since it has been found that these items have a definite effect on the life of the bearing.

Fig. 6—Finding resistance to failure of cord by winding over clips of same type as used on cleaner

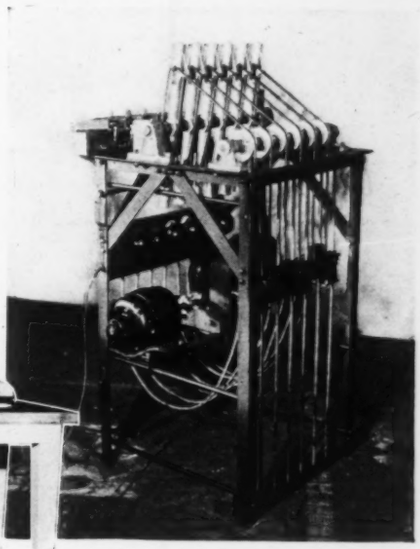


Fig. 4—(Right)—Circulating dirt through cleaner to determine effectiveness of bearing protection

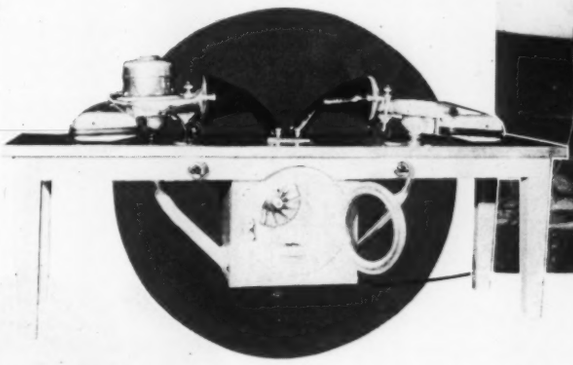
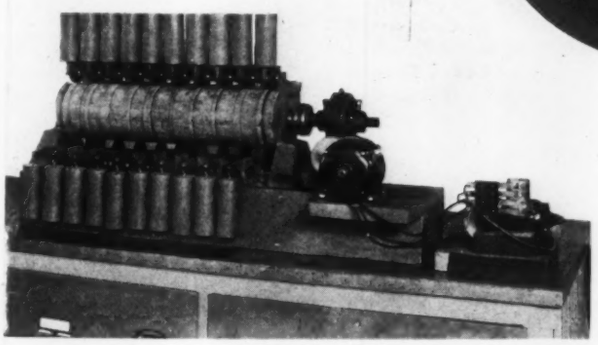


Fig. 5 — (Below) — Wheel test for hub wear and squeaking



Life Tests on Rubber Belts

To obtain constant conditions for testing the rubber belts used to drive the agitating member of the cleaner, a method was devised in which the load on the belt is supplied by an electrical eddy current brake (Fig. 2). The brake consists of an aluminum disk ¼-inch in thickness and 6-inch diameter which is revolved between sets of magnets energized by separate coils. The load of the brake is capable of being varied at will by changing the electrical input to the coils surrounding the magnets. This type of apparatus offers a flexible and accurate means of testing all types of rubber belts which

are used on the various models of cleaners having different loadings.

By correlating the results obtained on the actual field service with the tests made at the plant, the engineer is able to predict with reasonable accuracy the relative merits of new rubber compounds and also is able to evaluate the effects of changes in cross section, belt length and tension. It has been found that the results of belt test vary appreciably with temperature and humidity conditions. To insure uniformity of test conditions the room in which belt tests are made is kept at a temperature of 80 degrees Fahr. and a relative humidity ranging from 50 to 60 per cent throughout the year.

Rubber guards which are applied to the cleaner for the purpose of preventing marring of furniture are subjected to two types of deterioration. If the rubber compound is not of the proper composition, the furniture guard will

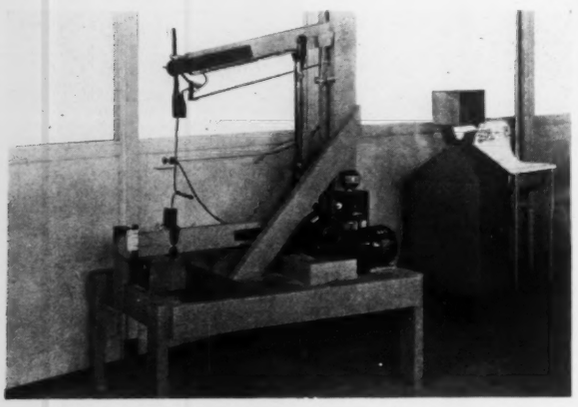


Fig. 7—Kinking test for electrical cords

crack open where bent around the corners of the machine due to slow oxidation and checking caused by the action of natural light. The guard also is subject to chafing action under certain severe conditions of service. In order to determine the relative resistance of various rubber compounds to ageing and surface checking the samples of furniture guards are bent back on themselves through an arc of 180 degrees and held in this stressed position while aged in an electric oven at 70 degrees Cent. in an atmosphere containing ozone.

Under these conditions the ozone accelerates the tendency to develop surface checking. Examinations of the surface of the test pieces are made at intervals of 4, 6 and 8 hours. This test is used for comparative purposes only and is incapable of numerical evaluation. Therefore, each time a new compound is to be tested it is placed in the oven adjacent to a sample of approved material. In this manner such variables as air circulation and ozone content of the surrounding atmosphere are eliminated and the test becomes useful in comparing various rubber stocks.

Chafing tests on furniture guards are accomplished by fastening the guard on a wooden block of definite weight having the same general shape as the main casting of the cleaner. This block is allowed to drop on edge from a height of four inches upon a grating made of hardened steel bars with sharp edges. The dropping procedure is continued for a definite number of cycles, after which a visual examination is made of the sample tested in comparison with control samples of accepted material. In order to preserve the results of ageing and chafing tests, photographs of the samples are made immediately after testing.

To evaluate the resistance of any electrical cord to failure by alternate bending, the device shown in Fig. 6 has been made for winding the cord over clips of of the same type as used on the handle of the cleaner and in approximately the same manner as in service. By the alternate winding and unwinding of the cord over these clips the copper conductors are subjected to fatigue comparable to that obtained in use. As soon as an open circuit or short circuit has occurred in the cords at the points contacting with the clips, the failure is indicated by the extinction of a light in the circuit. The counter recording the number of cycles of revolution also is stopped through an electromagnetic device.

Crude Tests Prove Satisfactory

Various methods have been tried to evaluate the abrasion resistance of rubber covered and fabric covered electrical cords. After much experimenting, a seemingly crude test has been found to be most dependable to evaluate this property. The cords in question are attached to a rack suspended from a motor truck and are dragged over a given course of concrete road covering a distance of 15 miles. In this test the sample cords are interspaced between samples of control cords of an accepted quality and the abrasion resistance is evaluated by a visual inspection after traversing the test course during a dry weather period.

While this test is not all that is to be desired, it has given valuable information concerning the merits of the various cords. Previous tests making use of abraiding mediums such as standard abrasive wheels have not been entirely satisfactory owing to the fact that the abraiding medium becomes loaded with materials of the rubber compound, in many cases providing a lubricating effect which is variable in nature. It is believed that the ideal abrasion testing machine would involve an abraiding medium which is continually renewed during the period of the test in order to avoid contamination from the rubber compound. The road tests partially meet this requirement.

Plastic Materials

Solve Many Problems in Design

By A. F. Clark

Editorial Representative, Machine Design

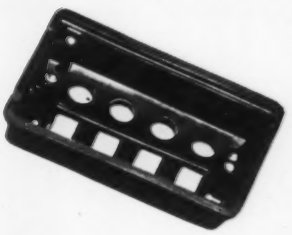


Fig. 1—Intricate molding and metal inserts add value to plastic materials. Photographs courtesy Auburn Button Works Inc.

WITH designers striving harder than ever to improve products and reduce costs, the elimination of machining and finishing operations, reduction of ncise and weight in the finished machine, and improved appearance are goals eagerly sought after. Because of their ability to combine many of these characteristics in one material, phenolic condensation products, composed mainly of phenol and formaldehyde, are being adopted in increasing numbers as materials of construction.

Application of the resinoids in the mechanical field are expanding rapidly and bid fair to duplicate the earlier extensive utilization in the electrical industry. The present trend in the use of these materials in applications apart from electrical insulation is based on their possession of a combination of additional properties, shown in the table below, practically all of which are inherent, but it also is true that they have been amplified in the last decade through the effort of organized research and development work.

Molded products are compounded from two general classes of raw materials—binders and fillers. The binders render the mass plastic and give it coherence, mechanical strength, chemical stability and insulation value. These binders are not a single product, but rather a comprehensive group of materials, many of which were developed in response to the requirements of a given service. Fillers are finely divided materials used to decrease shrinkage, cracking and variation in dimensions, to increase mechanical strength and toughness, and to lower cost.

Principal fillers used are wood flour, asbestos fiber, mascerated shirting and other types of fibrous materials, to which color pigment is added. Increasing the size of filler particles increases the resilience and gives added strength,

Typical Physical Properties of Phenol-Resinoid Products

	Molded			Laminated	
	Wood-flour filler	Fabric filler	Asbestos filler	Paper	Fabric
Specific gravity	1.3—1.4		1.8—2.0	1.3—1.4	
Tensile strength, lb. per sq. in.	New A.S.T.M. test piece 6000—12,000	New A.S.T.M. test piece, 4500—9000	New A.S.T.M. test piece, 5000—10,000	8000—24,000	8000—12,000
Impact strength (notched Izod specimen) ft.-lb. per sq. in.	1—2.5	10—25	0.5—4	5—25	10—65
Modulus of elasticity (transverse), lb. per sq. in. X 10^6	25	8—12	10—25	10—20	5—15
Modulus of rupture (transverse), lb. per sq. in.	10,000—20,000	8000—15,000	8000—20,000	Flatwise or edgewise 15,000—30,000	Flatwise or edgewise 15,000—25,000
Electrical resistivity (volume), ohms per cm. cube at 30 degree Cent.	10^{10}—10^{11}		10^8—10^9	10^{10}—10^{11}	10^9—10^{10}
Dielectric constant	4.5—8	4.5—7	5—20	4.5—6	4.5—7
Thermal conductivity, cal. per sec. cm. degree Cent. X 10^4	4—6		12—20	5—8	
Specific heat			0.30—0.40		
Effect of heat	Tends to harden and shrink slightly with improvement of electrical properties				
Effect of heat, Dry	Withstands 250 degrees Fahr. Does not fuse		Withstands 475 degrees Fahr. for short periods. Does not fuse.	Withstands 250 degrees Fahr. Does not fuse	
Effect of heat, Moist	Slight deterioration of electrical properties				
Effect of aging	No deterioration. Tends to improve in mechanical and electrical properties				

Table Courtesy Bakelite Corp.

but this advantage is offset by the decreased ability of the material to conform to intricate molds. Variations in the properties of the material are infinite, as one of the many grades of each type of filler may be chosen in accordance with the particular characteristics desired.

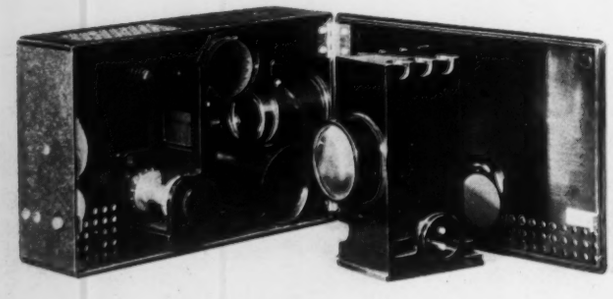
During the past five years the already extensive series of molding materials has been augmented by the development of molding materials of increased shock resistance. The impact strength of ordinary wood flour reinforced molding materials has a maximum of 2.5 pounds per square inch. New molding materials with special fibrous reinforcement offer an impact strength of 20 pounds per square inch.

Other molding materials have been developed which add to the color range, permit of more rapid molding, provide greater heat resistance, offer increased resistance to the carbonizing effect of the electric arc, and are improved as to power factor. The flexibility or resilience property also has been amplified.

Molded Parts Are Essentially Rigid

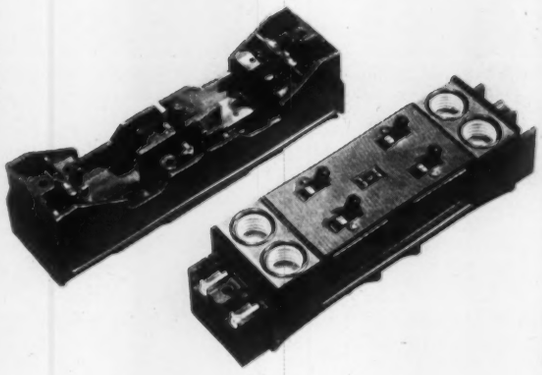
It must be appreciated that, in general, molded parts lack flexibility and elasticity. They are essentially rigid and do not withstand severe impact and vibrational loads as successfully as the laminated type, which will be described in the following, but they do possess a considerable degree of toughness and are satisfactory for most uses, provided they are designed correctly with proportions appropriate to their specific properties.

The molding process consists of shaping the resinoid powder, usually preformed into biscuits as a preliminary step, by means of hardened steel dies under pressure of about 2000 pounds per square inch at a temperature around 350 degrees Fahr. Through fusion and chemical action, the synthetic resin bonds the composition tightly and gives it an infusable, insoluble form. No weight is lost during the molding, but the material compresses to about 40 per cent of its original volume.



Courtesy General Plastics Inc.

Fig. 2—Entire case, partitions and film compartments of this projection machine are molded in one piece



Courtesy General Plastics Inc.

Fig. 3—Large railway electric switch with bushings embedded and holes formed during single press operation

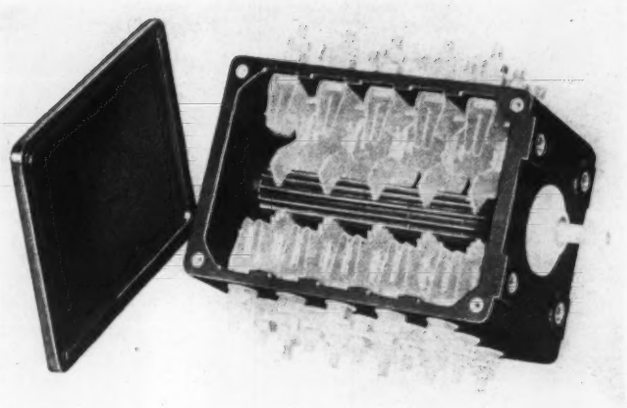
The operation takes place in highly polished, hardened, and ground steel molds which impart to the finished product with unerring precision a copy of their dimensions and finish which may include lettering, decorative effects, knurling, holes, and graduations, Figs. 1-3. No finishing operations are required with the possible exception of the trimming of a small fin which may be present with the use of an overflow mold.

In special cases the piece may be molded with an accuracy of plus or minus 0.002-inch although for most purposes 0.005-inch should be sufficient. It is this accuracy of reproduction and fine finish together with the readiness with which inserts of all kinds can be embedded securely during the molding process, and the intricate finished parts that can be fabricated, that makes molding materials peculiarly suitable for quantity production work. Fig. 2 shows a projection machine where intricate molding is combined with inserts to give an effective part. Strong, accurate threads and gear teeth, Fig. 4, for uses where the impact stress is not great, have been molded from these materials.

Other mechanical applications of molded parts include wheels for industrial trucks where the parts are called upon to withstand a good deal of compressive stress and shock, rocker arms for controls, and loom picker controls which are subjected to impacts and unusual stresses.

Although set rules cannot be developed for the design of molded parts, since the preferences of the designer must often be modified to conform with the limitations set down by the molder, there are a few general principles which should be of value:

When lettering is required, it is easier and cheaper to engrave or sink the letters into the mold, so as to produce relief molding on the finished piece. The opposite effect requires raised letters on the mold which are expensive to make.



Courtesy General Electric Co.

Fig. 4—The five gear segments on this rotor for a switch are examples of the uses of gears molded from resinoid material

Interior undercuts, thin-walled barrel pieces with exterior flanges, horizontal and oblique side holes, and right angle or curved tubular pieces are expensive to manufacture and a substitute design should be used wherever possible

Straight knurling running vertically into the mold is advisable instead of the diamond type

Grooves and threads that are coarse rather than fine give stronger clean-cut edges

The part should be designed so that required inserts can be placed in the mold readily. Horizontal inserts require vertical support

Inserts or pins which extend from top to bottom of mold or from side to side in a multiple mold closing in at the sides may be oversize and prevent tight closing thus giving a spongy product as well as an inaccurate one

Ample draft, or taper, on all projections and depressions in the product should be allowed

A minimum of $\frac{1}{8}$-inch of material between holes and the edge of a part, or a projection on it, is best practice

Resinoid products are nonhygroscopic, resist oil and solvents, are impervious to most acids, but are susceptible to attack by the caustic alkalies. Nickel plating solutions do not hurt them. They will withstand temperatures up to 302 degrees Fahr., but this temperature resistance can be somewhat increased by baking for 24 hours or longer at 266 degrees Fahr. The molded parts can be drilled, tapped or otherwise machined when necessary, but, as a general thing, such requirements can be provided for in the molding operation.

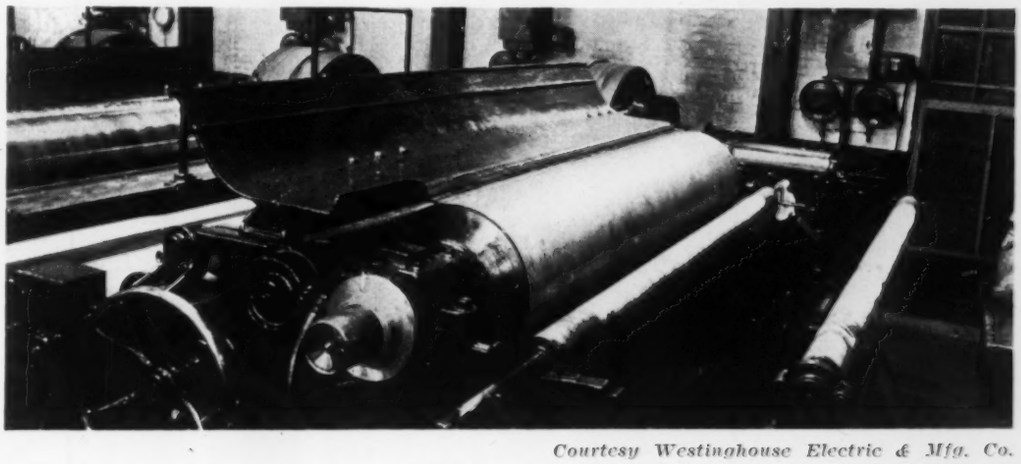
Phenolic-resinoid materials have, for specific purposes, replaced practically every known form of metal. An example of this replacement is the retainer rings for ball bearings, shown in Fig. 7. For the heaviest duty in machines it would appear that resinoids will not supplant metal, but it is conservative to assume that for many less strenuous services they will replace metal entirely.

Laminated Forms Have Greater Resilience

Where greater resilience, tensile and impact strength is required, the laminated type of phenolic-resinoid material is employed. This type is a dense, strong, solid material produced by the application of heat and pressure upon superimposed layers of paper, fabric or canvas impregnated with a body of phenol resinoid. It is hard, water resisting, dielectric, heat resisting and chemically inert. This rare combination of desirable properties makes it adaptable to a multitude of diversified uses. It may be obtained in sheets, coils, rolls and tubes and by the use of special filler and liner sheets, it may be made to fit the individual needs of many machine design problems. From these primal laminated forms finished articles are fabricated by machining rather than molding.

There is a type and grade of laminated phenolic material for every purpose in which flat or simple shapes can be used. Shapes with arms, lugs, cams, abutments, fins, etc., in fact any section that is not highly irregular can be made of this material either by building up of layers or by the use of a suitable matrix in place of the flat pressure molds used in making sheets while the material is under heat and pressure.

Laminated phenolic materials machine some-

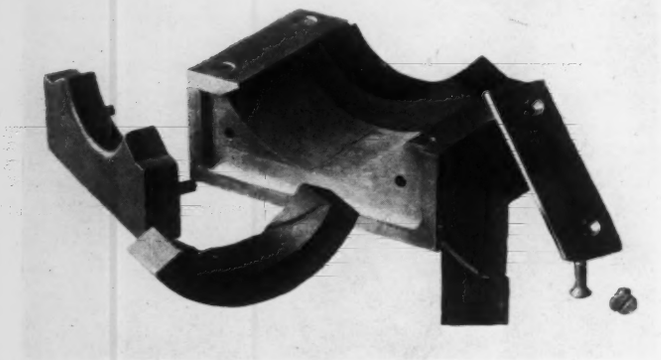


Courtesy Westinghouse Electric & Mfg. Co.

Fig. 5—A molded laminated material has been found superior for blades used to clean calender and dryer rolls of excess material

what similar to brass, and take a high polish. They may be sandpapered or ground on a wheel. They can be sand blasted and, although they resist nearly all acids, can be etched chemically. They also can be lettered or given other imprints with suitable stamping dies. A dull, ornamental surface finish is obtained by rubbing with suitable abrasive and finishing with oil.

In the paper laminated stocks designs and colors may be incorporated easily. These designs may take any form the user may desire such as mahogany finish, marble finish, trade marks and the like. They are printed on the top sheet of the laminated structure before the resin is applied. After the laminating process a hard impervious surface covers them.



Courtesy Westinghouse Electric & Mfg. Co.

Fig. 6—Disassembled view of roll neck bearing made of laminated material

Perhaps the most prevalent use of laminated stocks is in gears of all kinds. For this purpose specially prepared canvas serves as a base. For the small gears of washing machines, phonographs, etc., a fine linen is preferred.

Die-formed Blanks Used for Gears

In the manufacture of gears, die-formed blanks are an improvement over the board in uniformity of strength and in convenience of handling. In their manufacture, circular disks are die-cut from the treated canvas. These disks are axially staggered, so that warp and filler lines are spaced uniformly about the perimeter, and are processed under heat and pressure in an individual mold.

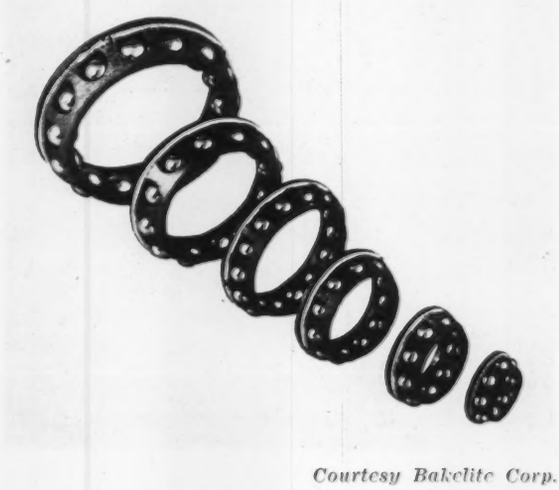
Blanks may be made with a thin flexible web, or with spokes with a rim of thicker cross section, and often include a steel hub molded in. The web thickness can be as little as one-fifth the thickness of the rim.

A laminated gear always should mesh with cut metal gears, never with other non-metallic gears, nor with metal gears having uncut cast, or badly worn teeth. The face width of the mating gear should be equal to or greater than that of the laminated unit.

The laminated material is twenty times as resilient as steel and weighs only one-half as much as aluminum. Laminated gears cut down noise on all kinds of machinery, thus preserving the nerves of workmen and increasing efficiency. They are flexible and take up shocks in the driving train. Their resilience distributes loads over more teeth.

A phenolic resinoid laminated material of extreme strength has given exceptional service as a bearing liner in wire, rod, bar and merchant mills. This material is constructed with a duck base. Installations are practical where pressures are not excessive and the peripheral speeds vary from 100 to 1000 feet per minute. Water alone is used as a lubricant without any change in the conventional cooling system. Impure water, containing weak acids and alkalies, has no effect on the material.

The three essential parts of the bearing, Fig. 6, are radial segments, thrust block and housing. The radial segments usually are 120 degree pieces so constructed that the wear at any point is at right angles to the grain of the material. The thrust block consists of a separate piece of phenolic resinoid so mounted that maximum life is afforded.



Courtesy Bakelite Corp.

Fig. 7—Laminated material used for ball bearing retainer rings

Laminated materials are suited for facilitating production under the following conditions:

Where the material can be cut to the desired form more readily than it can be molded

Where a small production does not warrant expenditures for costly molds or other special apparatus

Where large sheets, which cannot be molded, are required

Where maximum tensile strength and resilience are required

(*Concluded on Page* 50)

By H. F. Shepherd

DEALING with a comparatively recent development in diesel engine camshaft drives, the accompanying concise article is among the first to appear in published form on this subject. It will be of interest not only to internal combustion engine designers, but also to other engineers considering the application of roller or silent chains.

Use of Roller Chains Is Extended to Camshaft Drives

IN THE construction of large internal combustion engines, as in the diesel engine, a camshaft parallels the crankshaft at some higher level and actuates the valves. Valves are returned by spring force and the descent of the cam operated mechanisms as the valves close is accompanied by a negative camshaft torque except where the multiplicity of cylinders causes an overlapping of events. In any case the camshaft driving torque fluctuates violently, especially when cam-operated fuel pumps are used, and since each cycle endures but a fraction of a second kinetic effects are considerable. A slightly yielding drive is desired but vibration due to the action of mass on elastic members must be avoided.

The once conventional camshaft drive is shown in Fig. 1 although some designers preferred bevel gears.

Lower Gears Ran in Oil

Housings for the bevel and spiral gear drives reached an admirable though expensive state of perfection. The lower gears in each set ran in oil and pockets were arranged to intercept the oil thrown off whence it was conducted to the bearings.

From a manufacturing viewpoint the results were far from satisfactory. The use of spiral or bevel gears made necessary special provision for thrust, and great skill was required to align the drive.

Owing to necessary manufacturing limits the meshing of gears was variable and similar units exhibited notable peculiarities in sound except when skillful matching and fitting was attempted. To avoid the grief heaped upon them by such details in the building of hundreds of thousands of motors yearly automotive engineers introduced the silent chain for valve gear drives, greatly simplifying design and manufacture and certainly eliminating any annoying tendency toward individuality in the operation of motors of the same origin. For the same reason European designers of large engines of the diesel type adopted the roller chain for valve gear drives using vertical flights of many feet and pitches as large as 3 inches. Special chains of even greater pitch were designed for engines of high power. Their success was universal and such drives now are established in this country.

The roller chain had acquired a doubtful reputation by reason of its use for rear axle drives where it was required to work at high speed over pinion sprockets of too few teeth, with indifferent lubrication if any and with no protection from water and mud. Experience with it

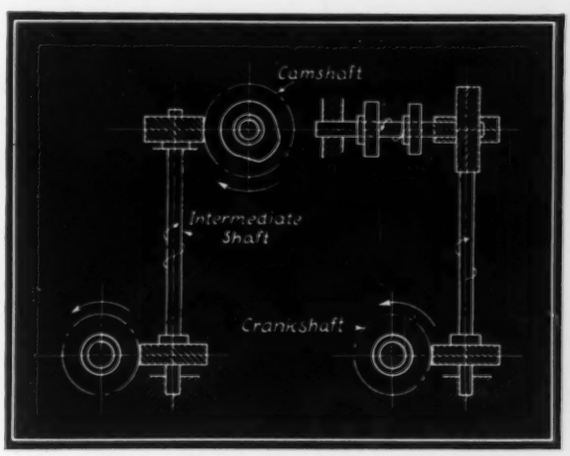


Fig. 1.—Early conventional method of driving camshaft by gearing

under better conditions has wiped out any prejudice of this sort.

Housed in an engine frame and lubricated with a stream of oil applied inside and near the approach to a sprocket, properly designed roller chain drives have shown no considerable wear after four years of use. The accuracy of timing effected is equal to any requirement. It is far better than that of right angle spiral gears when they have developed lash which they almost invariably do.

Oil Film Provides Damping

The yielding of the oil films at the many pin joints together with the elastic movements of the chain members reduces shock without tending to set up harmonic oscillation since the displacements are not strictly proportional to the loading. The oil films also provide damping.

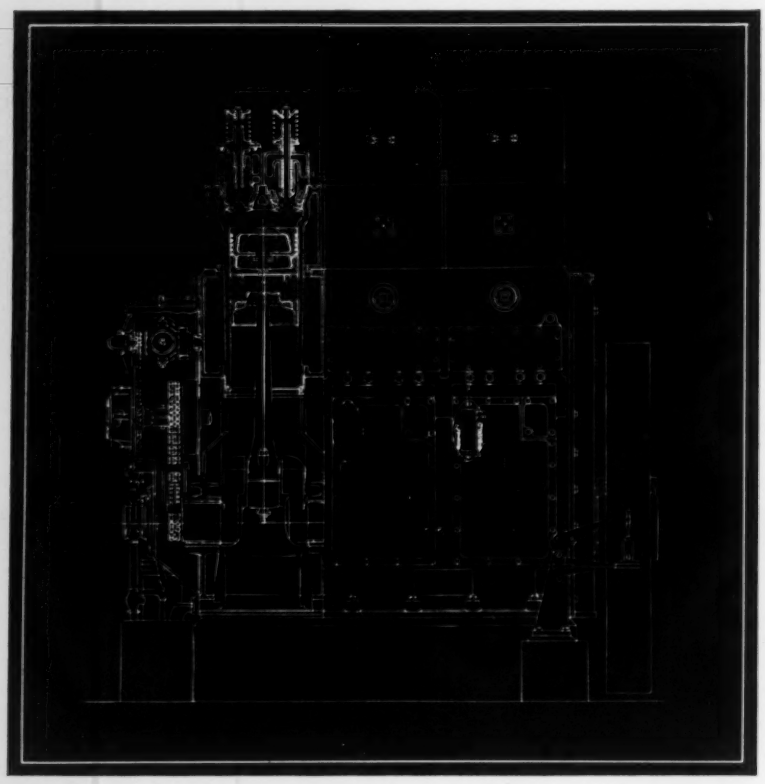


Fig. 2—Double strand chain camshaft drive with auxiliary drive to engine governor

In designing camshaft drives a torque curve is plotted from which the maximum chain pull is determined. While factors of safety as low as 20, or lower in certain cases, have been used successfully, for long chain life it is better to select a chain on the basis of pin load rather than breaking strength.

The design is based on a wear factor, not a safety factor. Neglecting the effect of centrifugal force about the sprocket the pin load should not exceed 900 pounds per square inch of projected area for heavy jobs. It never should be greater than 1200 pounds per square inch. This makes the ratio of breaking strength to working load equal 30 to 45 depending on the design of the chain.

For this type of drive the chain velocity should be limited to 900 feet per minute where possible and should not exceed 1200 feet. No sprocket in contact with the chain should have less than 19 teeth, preferably never less than 21 teeth.

Multiple chains of the double, triple or even quadruple variety are used to provide adequate strength with small pitch thus making possible the required number of teeth with reasonable pitch diameters and allowable linear velocities.

Every chain is provided with an adjustable jockey sprocket having a minimum of 19 to 21 teeth. It should be so located that at least three of its teeth are in engagement at any position. Jockey sprockets are best provided with antifriction bearings. In determining the position of the jockey, for any drive, it usually is advisable to locate it on the inside of the chain and thus obviate backward bending in passing over the jockey.

Fig. 2 shows a double chain camshaft drive. Jockey suspension can be noted between crank and camshaft. The governor is driven by a separate $\frac{5}{8}$-inch pitch roller chain at left of main drive. Chains are preloaded by the manufacturer, that is they are stretched on a draw bench under a pull exceeding the operating load, thus practically eliminating the initial or seating elongation due to wearing in.

Well designed drives of this type are given yearly inspection but rarely require adjustment at the first survey. In cases where adjustment is essential, however, it is a comparatively simple matter to take up the wear in the chain joints by means of the adjustable jockey sprocket. On smaller drives of similar nature, spring-loaded jockey sprockets are provided to give automatic adjustment. This is one of the features of many of the front end drives on automobiles. In other cases the chain is taken up at pump or generator shaft sprockets.

NEW and revised sections relating to screw threads, bolts and nuts, iron and steel and nonferrous metal specifications, and also a list of American standards of interest to the automotive industry are included in the 1931 edition of the Handbook of S. A. E. Standards and Recommended Practices. Copies of the publication have been distributed free to members of the Society of Automotive Engineers. Non-members may obtain it for $5.00 per copy.

Meeting Modern Conditions in New Gearing Formulas

By Geo. H. Middleton

SINCE the Lewis formula is not entirely suitable for gearing operating under modern severe conditions, numerous noteworthy substitutes are being derived. The accompanying article, first of a two-part series, covers an authoritative investigation of the contact of involute gear teeth and takes several new factors into consideration. The second section will follow next month.

IN THESE days of higher speeds and heavier loaded gearing, when everyone is trying constantly to reduce sizes and get the greatest capacity from the material at their disposal, the conditions of tooth contact must be given considerably more attention than was the case a decade or so ago. At that time the main essential was strength. The majority of gears were designed as cantilevers in the worst condition of loading, and the Lewis formula—with its variable shape factor y to take care of the weaker section of low number gears, together with a more or less empirical increase of safety factor for shocks at higher speeds—was used widely.

It has become recognized fairly well, however, that a purely strength formula like the Lewis formula—which gives equal strength for gears 5-inch pitch by 1 inch wide, and 1-inch pitch by 5 inches wide—is inadequate, and other considerations must be taken into account: Such as, number of teeth in contact, velocity of sliding, amount and characteristics of load-supporting areas, etc., all of which have their place in the final design of the gearing.

Research work on gears, however, still is limited, and sufficient progress has not been made to enable designers to enunciate a complete and reliable formula embodying all these points. In this investigation, only one of the essential factors will be dealt with, namely a mathematical consideration of the limits of spur gear tooth contact. The relation of gear diameters, numbers of teeth and amounts of contact will be given, and reference made to the limiting numbers of teeth under certain conditions.

Attention will be confined to the involute odontoidal system which now is adopted almost exclusively as a standard, because as a result of its straight "line of action," generating tools are comparatively simple to make and maintain; easily controlled tooth generation is assured, and variations of center distance can be accommodated simply without sacrifice of true contact and smooth mathematical running.

A few characteristics of the involute system will be postulated as a basis for this investigation.

Consideration of Interference

Referring to Fig. 1. The line of action is a straight line Tt, inclined at an angle to the line of centers OC and passing through the pitch point P. Its inclination may vary, but for any given system becomes fixed at an angle of 90 degrees minus the pressure angle β of the system which may be 14½ degrees, 15 degrees, 20 degrees, 22½ degrees, etc., according to the data used. Its total length is terminated at the points of tangency T and t, with the base circles of wheel and pinion, respectively, and the actual contact point must travel along this line exactly as a point on a string wrapped like a crossed belt over two pulleys of the base circle diameters and center distance of the gears.

Should the gears have fairly large numbers of teeth, contact does not extend the total length of the line of action, but commences and terminates at points A and L respectively, these points being fixed by the intersection of the addenda circles and line of action.

If, however, as in Fig. 2, either of the gears is so small that the point of tangency with the base circle lies inside the addendum circle of the mating gear, then this point t indicates the limit of useful contact. This can be understood if the generating action of a point on the line of action Tt is considered. As it approaches to, and then recedes from the tangent curve, a cusp sts^1 occurs on the theoretical tooth curve, which cannot be reproduced in metal, and therefore practical action must cease at the tangency point t, which

generally is termed the interference point.

This interference should be prevented, either by increase of pressure angle or correction of wheel addendum, as otherwise the extra projection of the wheel addendum, in continuing to sweep out its own clearance will sweep out an undercut curve, or trochoid, which cuts away a portion of the true involute curve, as illustrated by the tooth at *P*, not only above the base circle, but in extreme cases, even beyond the pitch circle. A study of a 10 or 12-tooth pinion generated by an uncorrected 14½ degree cutter will show this distinctly.

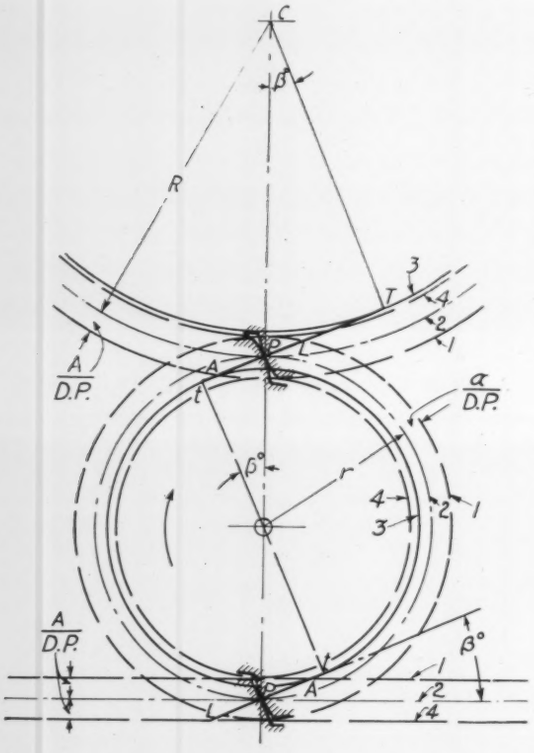


Fig. 1—Normal line of action is indicated by straight line shown at Tt

To enable the designer to know how and when to avoid interference and its consequent reduction of contact length, general formulas will be developed in the course of the investigation, and a chart offered for the B & S system, 14½ degree angle of pressure (actually 14 degrees 28 minutes 39 seconds, or $\sin^{-1} \frac{1}{4}$) with addendum equal to the module of 1/D.P.

The general questions to be answered by the study of involute contact may be expressed as follows:

(a) Does interference occur?

(b) How much must addendum or pressure angle be modified to avoid it?

(c) What is the length of contact line?

(d) How many teeth in contact?

These points will be considered first in connection with a rack:

(i) With a gear and no interference

(ii) With a pinion, interference present and how to correct

then following with the general case of:

(iii) Unequal gears, no interference

(iv) Unequal gears with interference present and how to correct

and proceeding to the special cases of:

(v) Equal gears, no interference

(vi) Equal gears with interference present and its correction

This will present a fairly comprehensive study of the problem, giving general solutions of each point, and particularizing on the B & S standard system; and from the results it will be easy to apply to any case needed such as the Fellows stub with 20 degrees pressure angle, or the 20 degree standard, addendum=¼ of the circular pitch (Nuttall standard.)

Data Used in the Article

C and O = centers of wheel and pinion respectively
R and r = pitch radii of wheel and pinion respectively
N and n = numbers of teeth of wheel and pinion respectively
T and t = points of tangency of line of action on wheel and pinion base circles
A = point of contact commencement
L = point of contact termination
P = pitch point
$A/D.P.$, $a/D.P.$ = addenda of wheel and pinion respectively
β = pressure angle
x = rack tooth correction height
h = corrected gear addendum height
1 represents addendum circles
2 represents pitch circles
3 represents base circles
4 represents working depth circles

First the cases (i) and (ii) of rack and gear will be considered and studied with a view to solutions of the four essential questions enunciated in the foregoing.

(a) *Does interference occur?*

This practically is answered by the postulates laid down, as it will be obvious that interference will be present commencing at the point when t coincides with the addendum line of the mating gear; in this instance the rack. The mathematical limit may be obtained from reference to Fig. 3.

$$\frac{MP}{OP} = \frac{MP}{Pt} \times \frac{Pt}{OP}$$

$$= \sin\beta \times \sin\beta$$

That is,

$$MP = r\sin^2\beta$$

If MP has a value equal to the rack addendum of $A/D.P.$, the pair is just at the interference limit. If MP has a larger value, then there is no interference, but should MP be less than $A/D.P.$, then there will be interference. This

gives the general formula for the point of interference with a rack, viz.:

$$\frac{A}{D.P.} = r \sin^2 \beta$$

but

$$r = \frac{n}{2\ D.P.}$$

and by substitution,

$$A = \frac{n}{2} \sin^2 \beta \quad \text{.....(1)}$$

Evaluating for the particular case of the B & S system where the addendum constant $A=1$, and sin $\beta = \frac{1}{4}$, this becomes:

$$1 = \frac{n}{2} \times \frac{1}{4} \times \frac{1}{4}$$

and

$$n = 32 \text{ teeth} \quad \text{.....(1a)}$$

or interference with the rack in the B & S system commences at 32 teeth.

It might be well to mention in passing, that there is a possibility that interference *may* occur higher than 32*T* in the B & S system. The reason for this is that the hob or generating cutter must have an addendum equal to the dedendum of the gear, and if the cutter have an uncorrected profile, the value at interference point would be:

$$\frac{1.157}{D.P.} = \frac{n}{2\ D.P.} \times \frac{1}{16}$$

whence

$$n = 37 \text{ teeth} \quad \text{.....(1b)}$$

In practice, however, the limit is seldom reached as the generating tools are rarely made with sharp corners, and with the correct radius on the corners of the teeth the effect is not noticeable above about 30 teeth.

(b) *How much must addendum or pressure angle be modified to avoid interference?*

Should the point t fall within the addendum circle by an amount $= x$, then this would be the necessary amount to reduce the addendum of the rack to prevent interference.

Then, correction,

$$x = \frac{A}{D.P.} - MP$$

$$= \frac{A}{D.P.} - \frac{n}{2\ D.P.} \sin^2 \beta$$

$$= \frac{1}{D.P.} \left(A - \frac{n}{2} \sin^2 \beta \right) \quad \text{.....(2)}$$

For the B & S system,

$$x = \frac{1}{D.P.} \left(1 - \frac{n}{32} \right)$$

$$= \frac{1}{D.P.} \left(\frac{32 - n}{32} \right) \quad \text{.....(2a)}$$

This decrease in the value of the addendum of the rack of course shortens the length of the contact line of the pair, and hence the number of teeth in contact. Whenever possible to increase the center distance, therefore, it is good policy to enlarge the diameter of the pinion by twice the amount given in the formula (2a) and spread the centers accordingly.

The Brown & Sharpe Mfg. Co. in its book, *Formulas in Gearing,* recommend that the outside diameter of the gear be increased to:

$$0.9375 \frac{n}{D.P.} + 4 \text{ addendum} \quad \text{.....(2b)}$$

which can be seen to be merely another arrangement of the formula (2a), by adding twice the amount x to the pinion diameter in place of reducing the rack addendum.

If it is not desired to shorten the rack, and the centers are fixed and thus prevent increase of diameter of pinion, then the pressure angle may be changed.

Formula (1) has shown that:

$$A = \frac{n}{2} \sin^2 \beta \qquad \text{then } \sin^2 \beta = \frac{2A}{n}$$

and

$$\sin \beta = \sqrt{\frac{2A}{n}} \quad \text{.....(3)}$$

or

$$\cos \beta = \sqrt{1 - \frac{2A}{n}} \quad \text{.....(3a)}$$

These formulas will provide a method for finding the minimum pressure angle for no interference.

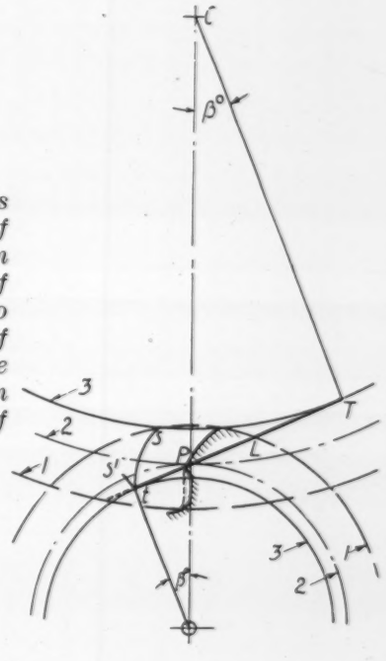


Fig. 2—Point t is limiting point of useful contact in cases where one of the gears is so small that point of tangency with base circle lies within addendum circle of mating gear

The next problem is to determine:

(c) *What is the length of contact line?*

When there is no interference, and point t lies outside the addendum of the rack, the total

length of contact line is AL. This may be calculated as follows:

$$AL = AP + PL$$

now

$$AP = \frac{A}{D.P.} \times \frac{1}{\sin \beta} = \frac{1}{D.P.} A \operatorname{cosec} \beta$$

and

$$PL = Lt - Pt$$

$$= \sqrt{\left(r + \frac{a}{D.P.}\right)^2 - (r \cos \beta)^2} - r \sin \beta$$

$$= \sqrt{r^2 + \frac{2ar}{D.P.} + \frac{a^2}{D.P.^2} - r^2 \cos^2 \beta} - r \sin \beta$$

$$= \sqrt{r^2 \sin^2 \beta + \frac{2a\,r}{D.P.} + \frac{a^2}{D.P.^2}} - r \sin \beta$$

but

$$r = \frac{n}{2\,D.P.}$$

therefore

$$PL = \frac{1}{D.P.}\left(\sqrt{\frac{n^2}{4} \sin^2 \beta + an + a^2} - \frac{n}{2} \sin \beta\right)$$

and

$$AL = \frac{1}{D.P.}\left(\sqrt{\frac{n^2}{4} \sin^2 \beta + na + a^2} - \frac{n}{2} \sin \beta + A \operatorname{cosec} \beta\right) \quad (4)$$

Specially evaluating for B & S standards:

$$AL = \frac{1}{D.P.}\left(\sqrt{\frac{n^2}{64} + n + 1} - \frac{n}{8} + 1\right) \quad (4a)$$

Should interference be present, and t be on or within the addendum circle, then contact is dependent on the pinion only, and its length will be equal to Lt. From the derivation of formula (4) it is found that

$$Lt = \frac{1}{D.P.} \sqrt{\frac{n^2}{4} \sin^2 \beta + na + a^2} \quad (5)$$

and for B & S standard,

$$Lt = \frac{1}{D.P.} \sqrt{\frac{n^2}{64} + n + 1} \quad (5a)$$

As a matter of interest, the special case of two racks meshing might be mentioned; contact being considered mathematically along the line of action AL. Its length will be:

$$2 \times AP = 2 \times \frac{A}{D.P.} \times \frac{1}{\sin \beta}$$

$$= \frac{1}{D.P.} \times 2A \operatorname{cosec} \beta \quad (6)$$

This is the maximum theoretical contact which can occur, and for B & S standard equals

$$\frac{8}{D.P.} \quad (6a)$$

(d) *How many teeth in contact?*

To determine this, it must be remembered that the pitch of contact of teeth is *not* the pitch of the gear as usually measured, but the pitch along the line of action and around the base circle. Each odontoid springs from the base circle and the action is normal to the teeth along the line of action, and hence the base circle pitch must be used in determining numbers of teeth in contact.

In the writer's opinion, the base circle pitch is the most important measurement in the mathematics of the gear, more so than the standard pitch on the pitch diameter. The peculiar property of involute gearing, that of running at varying centers, is best studied through the base circle pitch, as this remains constant; while with each change of centers, the running pitch diameters change, and with them the pitch of the teeth.

The base circle diameter is equal to $(n/D.P.)$ cos β and hence the base circle pitch is equal to:

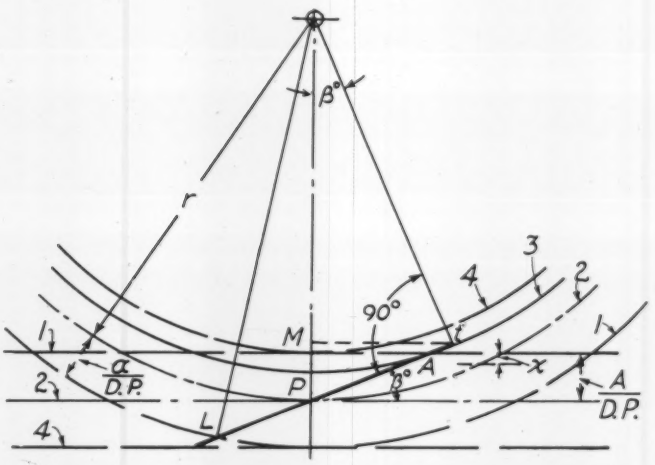


Fig. 3—Interference commences when point t coincides with addendum line of rack

$$B.C.P. = \frac{n}{D.P.} \times \cos \beta \times \frac{\pi}{n}$$

$$= \frac{\pi}{D.P.} \times \cos \beta \quad (7)$$

For B & S standard,

$$B.C.P. = \frac{3.042''}{D.P.} \quad (7a)$$

To find the number of teeth in contact in any pair, it merely is necessary to evaluate the formulas for length of line of contact, i. e., numbers (4), (4a), (5), (5a), (6) and (6a), and divide by the base circle pitch, number (7) or (7a). As an example, take the rack formula (6a), and evaluate, which will give a value of:

$$8 \div 3.042 = 2.62$$

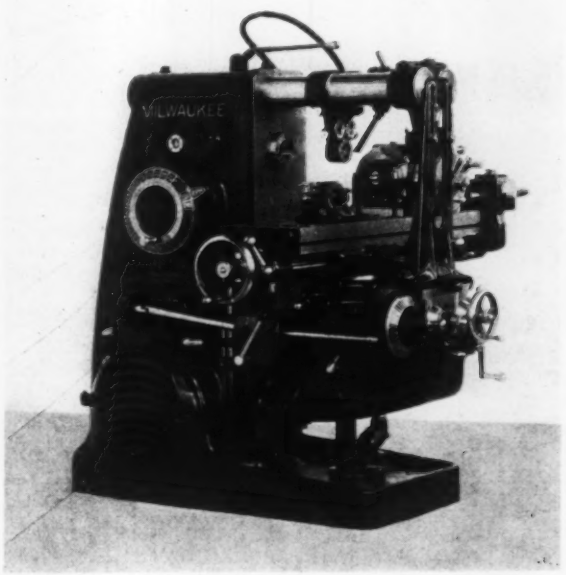
This represents the maximum possible number of teeth in contact in any gear pair in the Brown & Sharpe system.

Savings May Warrant Redesign

HOW will developments in machine tools employing tungsten and tantalum carbide cutting tools affect the design of machine parts? This question suggests the desirability of close study of new units such as the milling machines developed recently by Kearney & Trecker Corp., Milwaukee. These machines are outstanding and may be the means of changing the routing of many machine details through the shops. Changes in design of parts to permit production by milling instead of other operations also may prove advantageous.

Rigidity Is Primary Consideration

In order that the machines will be capable of withstanding the severe strains imposed on them by the use of the new super-cutting tools, and also to obtain the longest possible life from the tools, extreme rigidity has been provided. The primary method of obtaining this is by massive construction throughout. Another feature is the mounting of the motor with its axis at right angles to the machine spindle, with the motor opening at the side of machine. This strengthens the machine column by eliminating the opening for the motor at the rear, and has the added advantage of providing accessibility to the motor at both ends. For rigidity of the spindle mounting three bearings are employed, spaced at approximately equal distances apart on the spindle.



Milling machine developed for use of tungsten and tantalum carbide tools

In the design of the arbor supports a distinctly forward step has been made. The center arbor support is hinged in two halves, each bored to fit over one overarm and locked together as one piece. Thus when it is desired to remove the arbor with its cutters assembled, each half of the hinged support is swung around it's respective overarm and the arbor can be removed with cutters intact.

Multiple V-belts are used from the motor to the driving pulley. The latter is of fan construction—an idea which is gaining rapidly in popularity—drawing air in through louvres in the motor door, past the motor and out through louvres in the door at the opposite side.

Lubrication has been accorded serious design consideration. Automatic flood lubrication is supplied for all gears, shafts and internal mechanism, the box section of column, at the rear of the motor, providing a large reservoir for the lubricant. An oil filter keeps the oil clean and free from grit. Not only is the main driving mechanism provided with flood lubrication, but the knee, being a completely enclosed box, permits a similar system to be utilized for gears and other running parts in the knee. A separate constant speed pump is used for this purpose. Provision for adequate, automatic lubrication also is made at the front arbor support, this being designed with an oil reservoir to make the bushing self-lubricating.

Incorporates Wide Range of Speeds

To provide the greatly broadened range of spindle speeds from 15 to 1500 revolutions per minute, the 27 speeds have been divided into three series of nine each. The nine highest speeds are obtained through silent gearing, the drive consisting of a hardened ground and polished gear on the spindle driven by a chilled cast-bronze gear at a ratio of 2½ to 1. By this arrangement, while the spindle may run as high as 1500 revolutions per minute no other shaft or gear in the entire train exceeds 600. Nine intermediate speeds are obtained through a hardened steel spur gear in combination on the spindle with a heavy duty gear for the nine lowest speeds.

With the high spindle speeds possible, and a feed range from ¼ to 60 inches per minute, it is anticipated these machines will revolutionize milling operations and provide many opportunities for reducing production costs.

Editorial

Management Should Not Underrate Its Responsibility in Design

WHENEVER a design is proved to be faulty the natural impulse is to blame it on the engineering department. In many cases this is unjust because engineers—through no fault of their own—often are not responsible.

Take a typical case. The engineers design a certain part, figuring that it must weigh 200 pounds to provide the necessary strength and rigidity. Before it gets into production, pressure is brought by some outside influence to reduce the section of this part. The controversy goes to the management, which overrules the engineering department. After the machines are in service the parts fail, and those not familiar with the circumstances assume that the engineers have made another mistake.

Recently the cast steel sternposts of five new United States cruisers broke when the vessels were undergoing rigorous tests. Assistant Secretary of the Navy Jahncke explained that "every effort was made for lightness . . . to keep within the treaty limit of 10,000 tons displacement. This resulted in drawing the line too fine in the design of the sternposts. . . ."

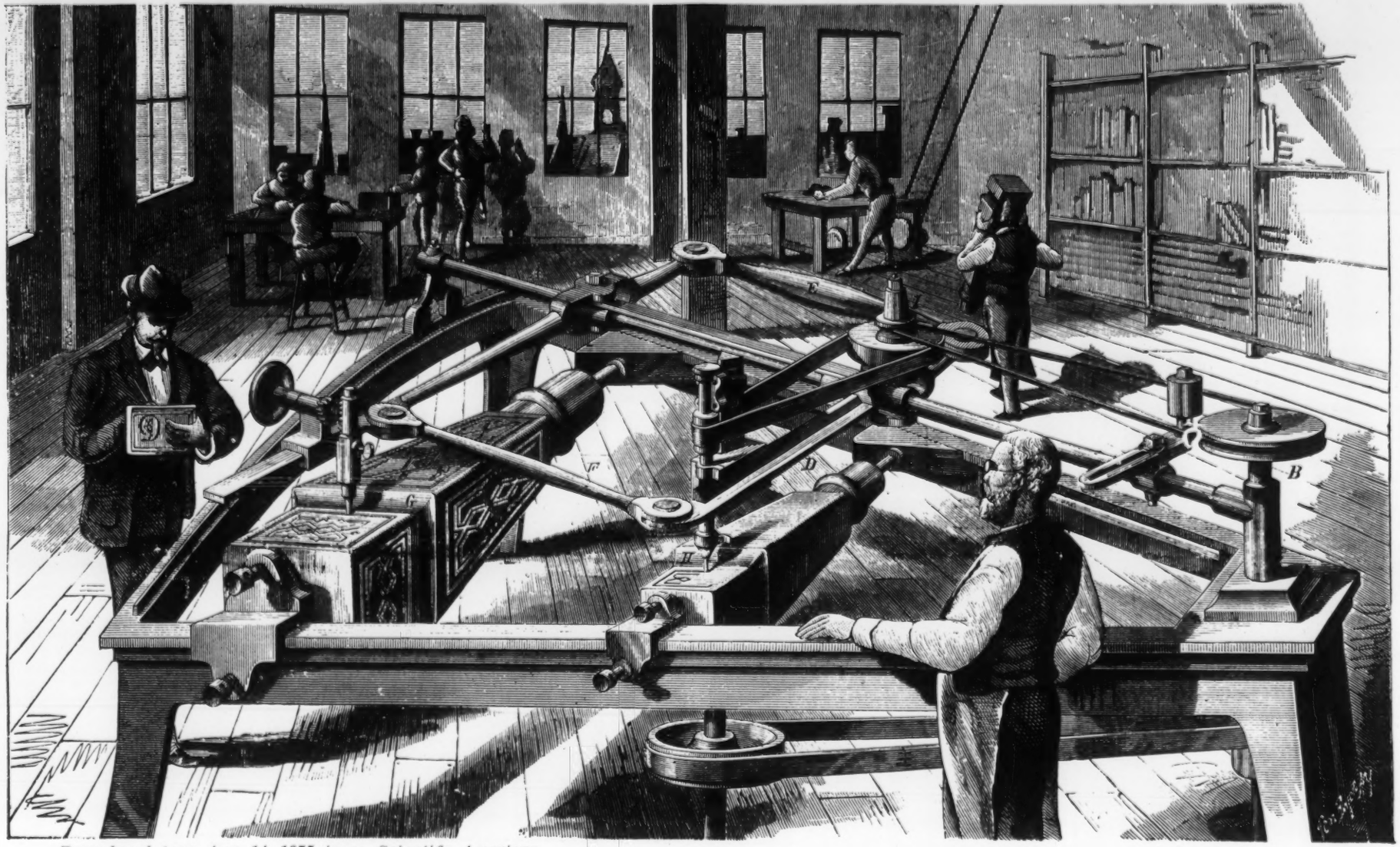
Here again the fact the design was faulty seems to reflect on engineering. If the designers of their own will skimped on the section of the castings, then they are guilty of poor design. But if, as seems more likely, the navy department's desire for lightness in effect coerced the designers into developing light sections against their better judgment, then navy policy and not engineering was at fault.

Too often the sins of management are visited upon the design department!

Reducing Hours—and Payrolls

NECESSITY for reduction in working hours with consequent decrease in payrolls is essentially a creation of the present depression. To claim that the step is not justified, at least in many branches of the engineering industry, would be short-sighted.

But there is one phase of engineering—design—which should be exempt from reduction either in payrolls or hours. This is recognized by many leading companies whose engineering department staffs have been retained or even increased. If the official working hours of engineers responsible for design were to be decreasd generally, the result could be but an extension of the depression. Design work must continue, and the more outstanding the developments the sooner will conditions return to normal.



Reproduced from Aug. 14, 1875 issue, Scientific American

Early Machines — A Pantograph Adaptation

AND the same idea still is being applied! One of the latest machines embodying it is the torch cutter, utilizing similar motions but refined to meet present conditions. The outstanding development in machine shown above was the provision for reproducing raised or indented portions of the tracer by balance of parts.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Design Initiative—Effect on Depression

To the Editor:

IN THE July issue of MACHINE DESIGN you quote with approval the suggestion of a well known engineer that business will be helped to revive by the creation of new industries and new things that people wish to buy.

In the somewhat guarded way in which you give your endorsement your attitude is entirely correct, and there can be no quibbling about the idea that new industries furnish new employment. On the other hand, the idea that depressions can be cured simply by advertising and by making things that people want to buy, is a type of optimism which will keep us floundering in the chaos in which we now find ourselves.

In 1930 the wage rolls shrunk about ten billions of dollars from 1929. Just by that much the wage earners became less able to buy what they want. The big problem is to get those ten billions of dollars back into the pockets of the wage earners, and, for increased prosperity, a good deal more. This, the engineer referred to knows very well. He has set that forth quite clearly in a long article in the *Saturday Evening Post*. But manifestly that cannot be done simply by advertising; nor can it be done in any dependable and systematic way by new industries.

New industries, important inventions, cannot be made to spring up and grow at a word of command. The airplane has been with us for thirty years. During that period the automobile has become a huge industry. But the airplane has had to be babied along by government subsidies, and in spite of all fervent wishes, refuses to become a leading industry even now.

Moreover, it should not be forgotten that while some inventions create new employment, there is another type of inventing going on all the time which has the opposite effect. The automobile industry has in the course of thirty years grown to one which in prosperous times has employed directly and indirectly as many as four millions of workers. Yet at present the automobile industry actually is learning to produce more cars with less men.

The most sensible thing which so far has been suggested to start the wheels of industry moving, is to commence immediately a thorough modernization of all plant facilities. Do not let us forget, however, that this, to create prosperity, does not mean the expenditure of only a few millions of dollars. It means the expenditure of ten *billions* of dollars a year. This is the extent to which banks and reserve funds must be drawn on to set things really humming again.

The engineer you refer to has, I believe, among other things some very definite ideas about how to make people's dwellings more healthy and habitable by means of air conditioning. Unfortunately the majority of this nation at the present time are too uncertain about the roof over their heads to have much chance to think of luxuries under these roofs. However, let the nation *systematically* take up the problem of good homes for its citizens and Mr. Kettering and his associates will have their chance.

—C. A. NORMAN,
Columbus, O.

To the Editor:

REFERRING to the editorial in the July issue of MACHINE DESIGN, where reference is made to Charles F. Kettering and his statement:—"Business will come back when we get some products that people will buy," I wish to take issue with Mr. Kettering by saying that if he will furnish men with money to manufacture the products he mentions so easily, he will find plenty of new designs and plenty of new products.

The paper mills are concerned about getting a cheap noncorrosive material. They will buy it if placed on the market, but they will not invest one cent to experiment or to manufacture it. The next thing is to find some man with money and vision, who will spend some of his money to experiment with and manufacture that noncorrosive product. This is one item only.

At the time to which Mr. Kettering refers, men were accustomed to spending money to get money. Everything was investigated that gave promise of a successful termination, and with

but few exceptions anything showing a ray of promise was tried out. Today on the contrary, all men with money are hoarding every cent. Nothing will be taken up by any man or combination of men, that will not promise at least 100 per cent profit, immediately, not next year, but today. Start a thing this morning and it must show a profit by night or it is not wanted, but they wail that they can't sell their products designed twenty years ago.

This is not a direct challenge to designers, the creators of machinery, but to the manufacturers. Find the men with the money and the mind to produce and you will find plenty, yes, thousands of new ideas.

A general manager when approached regarding a new idea said: "Yes, I believe it is good. I believe that in the long run it will pay, but should it not pay, I would be the goat. I won't recommend it."

A secretary of a chamber of commerce said: "You are only one of 7000 who have written us within the last year. We won't put out one cent to experiment, but we have thousands to spend to bring in a branch of a going firm or to bring in a firm manufacturing or selling a tried product."

Charles M. Schwab wishes he could live over again only one episode of his life—that in which he refused to finance the Wright brothers aviation venture.

After this flurry, say ten years from now, many men will say "If I only had."

—C. G. WILLIAMS,
Green Bay, Wis.

Will Needle Bearings Gain Headway?

To the Editor:

APROPOS of the subject of needle bearings discussed by R. A. Perrett in the June issue of MACHINE DESIGN I wish to offer the following comments:

This type of bearing was in vogue about 20 years ago, especially with slow speed shafts. It was used both with and without cages for the rollers but best results were obtained with some sort of cage to keep the rollers properly spaced. The greatest objection to this bearing was the tendency of the rollers to become dislodged causing a wedging action to result.

Suitably well designed roller bearings that are self contained are available in a great variety of standardized sizes. These are used in large quantities that enable them to be manufactured at a cost so low that makes their use as economical, or even more so, than the so-called needle bearings.

Furthermore the sales value of an advertised bearing that has proved its merits is not to be overlooked. This appeals to the sales force and in many cases they become enthusiastic about it. It breaks down sales resistance and helps to increase sales.

The use of antifriction bearings is on the increase but I do not believe that the needle bearing will again gain a foothold.

—CARL E. SCHIRMER,
Springfield, Ohio

Weights of Materials Found Easily

To the Editor:

RECENTLY I had a problem of finding the weights of materials of several of the more common shapes and of different kinds of materials. This was rather cumbersome until I developed the formulas given in the following:

It will be found that almost any kind of material may be calculated from these formulas. They are based on specific gravity and incicentally the weight of a column of water and are therefore on a logical basis.

They are

$0.0283D^2LS$ = weight of rounds
$0.0312D^2LS$ = weight of hexagons
$0.0360D^2LS$ = weight of squares

Where

D = diameter or distance across flats in inches
L = length in inches
S = specific gravity

These formulas have proved satisfactory in many trials. The results come well within working tolerances of the tables published by the Steel Institute.

—KARL A. ECKHARDT,
Cleveland

Saving Time in Mechanical Design

To the Editor:

MOST engineers and draftsmen are familiar with the use of cross section paper in making free hand sketches. These sketches are made either directly on the cross section paper or on transparent tracing paper held over the cross section paper.

Recently it occurred to the writer that inasmuch as a freehand drawing could be made without using a scale, and still have it to size, that there was no reason why one could not also make scale drawings in the same manner. Inquiry revealed the fact that cross section paper could

be obtained which was 15 to 20 inches in size, and accurately ruled. It was found that by tacking this paper to the drawing board, underneath the tracing paper, the use of the scale could be dispensed with.

For making large drawings, two or more of the sheets may be fastened together on the drawing board. When making drawings full size, especially where a design is being worked up at the same time, a saving of 25 per cent often may be made in the time required to make a drawing.

—R. A. BLACK,
San Francisco

Making Drawings More Readable

To the Editor:

NOT being aware in what class of work Edward Heller is engaged, the writer cannot judge how complicated the drawings are which he discussed in the June issue of MACHINE DESIGN. While it is perfectly feasible on simple drawings to follow Mr. Heller's suggestion to write all notes and dimensions horizontally, it is the writer's experience that on complicated drawings it is absolutely necessary, for safety and clearness, to place dimensions in a break in the dimension line and to read in line with it. If the usual standard method of dimensioning is used, the figures are read with very little turning of the head except for an occasional diagonal dimension which, owing to crowded space, may have had to be sloped from upper left to lower right. In this latter case it would be justifiable to write the figure horizontally and, if necessary, to use a leader line to the break in the dimension line.

—W. S. BROWN,
Auburn, N. Y.

Consider Designers' Comfort!

To the Editor:

FREQUENTLY machine designers have to work against time; and accuracy and speed do not blend well. Working conditions therefore should be as favorable as possible. One of the greatest factors contributing toward this is the provision of separate offices for all designers doing important work necessitating keen and continued concentration.

In a private office a man can work undisturbed in comfort, privacy and an atmosphere to his own liking. There should be every facility to regulate temperature, ventilation and lighting to suit the individual temperament. A private office permits and encourages individuality a trait that is vital to designers. When working in a large office all have to conform en masse to customary ways and conditions. All the leading authorities on concentration emphasize that what may be favorable working conditions for one man, may be the reverse for another. Adequate light, and ability to adjust and screen it to one's fancy is most important.

If it is impracticable to have separate offices for the leading designers, there should at least be a part partitioned off to give some degree of quietness and privacy.

—ALFRED C. LAYZELL,
East Paterson, N. J.

Plastic Materials Solve Many Problems in Design

(*Concluded from Page* 38)

A comparison of the specific strength of resinoid material may be obtained from the following:

Material	Tensile strength tons per sq. in.	Specific gravity	Specific strength
Steel	60.0	7.85	7.6
Laminated resinoid material	10.0	1.35	7.4
Duralumin	18.0	2.75	6.5
Spruce	2.5	0.48	5.2
Resinoid material (molded)	2.5	1.35	1.85

The advantages of production speed and laminated strength can be combined in a single part where added strength is needed for a portion of this part such as lug subjected to higher stresses. In this case small sections of canvas or similar material are laid in the mold and the usual molding process followed.

There is no standard product of plastic material. This contribution of chemistry to industry has such a wide range of basic compounds, and may be used in connection with so many types of fillers or laminating sheets that it can be adjusted to suit almost any set of conditions. The designer must first outline the requirements of his part. Then a model should be made and tested to ascertain the exact reaction of the applied specifications to the problem. When these matters have been ironed out the molds can be made or laminating details outlined, and production commenced.

For assistance in the preparation of this article the co-operation of the following companies is gratefully acknowledged: Auburn Button Works Inc., Auburn, N. Y.; Bakelite Corp., New York; Continental Diamond Fiber Co., Newark, Del.; General Electric Co., Schenectady, N. Y.; General Plastics Inc., North Tonawanda, N. Y.; Northern Industrial Chemical Co., Boston, Mass.; and Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

ASSETS TO A BOOKCASE

Review of Books Pertaining to Design

A Career in Engineering

Autobiography of An Engineer, by William Le Roy Emmet, 213 pages, 5½ x 8½; published by Fort Orange Press, Albany, N. Y., and supplied by MACHINE DESIGN for $2.00 plus 15 cents postage.

Out of the ranks of engineering comes a whole-souled expression of the inner life of an eminent personality; it is an autobiography of William LeRoy Emmet. To this famous inventor and engineer goes the credit of setting a precedent in the profession by giving to posterity historical and technical facts that have served to mold his career. He stands today as one of the famous quartet of General Electric's creative force, Elihu Thomson, Charles P. Steinmetz, Willis R. Whitney and William LeRoy Emmet.

Since his graduation from the Naval academy at Annapolis in 1881 he has worked earnestly in the electrical industry which had its beginning about that time. In his own words he relates the trials and tribulations that were undergone by him and his associates, particularly during the electrification of street railways.

From his early experiences he gained a thorough knowledge of the basic fundamentals in practical engineering. Generalship and executive ability alone will not successfully lead in engineering, he says. Knowledge of detail is imperative in getting designs made. It also is necessary to inspire conviction in the minds of prospective purchasers. In large constructions of new types much of the selling must be done by engineers who have positive conviction as to reasons. Uninformed people cannot inspire the necessary confidence.

The foregoing is only one of many expressions of wisdom that have been injected into this brilliant autobiography. His experiences in the turbine department which he created for his company are most interesting. Dr. Emmet was responsible for a great deal of the development of the Curtis turbine. Another insight into his broad vision is given in the fact that it was at his suggestion that stator frames for turbo-alternators and other kinds of machines were first fabricated by electric welding from rolled plate material instead of being made from castings. His discussion of the part he played in this revolutionary development is intensely absorbing.

At the conclusion of his book he outlines his work in the development of mercury vapor turbine which is proving to be an important factor in the conservation of coal. One highly interesting possibility of the mercury process is in its application to ships. Reference is made to the plans which have been studied for the application of this process.

It may be remembered that a picture and biographical sketch of him appeared in the April, 1930, issue of MACHINE DESIGN.

□ □ □

Technical Data Explained

Applied Kinematics, by J. Harland Billings, cloth 173 pages, 6 x 9 inches; published by D. Van Nostrand Co. Inc., New York, and supplied by MACHINE DESIGN for $2.50 plus 15 cents postage.

Despite the fact that theory of mechanism and principles of kinematics have undergone no appreciable change in the past two decades there has been a marked shift in the relative importance of their applications. That, if for no other reason, sets apart a new technical book covering this aspect of engineering from less recent volumes, the discussion of applied kinematics by Mr. Billings belonging to the former category.

One of the outstanding subjects treated deals with acceleration. This is consistent with the modern trend toward higher speeds in machines and is deserving of its prominence. General methods of solution have been used in preference to methods adapted to particular mechanisms. It is noteworthy that the general solutions for acceleration in direct contact mechanisms as given in the chapter on cams are new, so far as the author has been able to determine.

The book is replete with discussions on theory of mechanisms in which chains are explained, parallel and straight line mechanisms, velocities in mechanisms, gears and their combinations, flexible connectors such as multiple belt drives, and in conclusion problems in the engineering department.

Since it has been found that the graphical method generally is speedier and more enlightening, the writer has used it freely. It has been correlated with analytical methods where that seemed desirable. Inasmuch as the author regards the study of inversion and the solution of velocity problems as the best key to an understanding of link mechanism, he has included three distinct graphical methods for the determination of velocity.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

WHEN the Henderson medal was awarded recently by Franklin Institute the honor went to Dr. A. N. Talbot, professor of engineering, University of Illinois. His meritorious inventions and discoveries in the field of railway engineering won him the token. Studies conducted by Dr. Talbot include several types of locomotives used by four railroads, and cover effect of speed, counterbalance, and design of the locomotives in relation to stresses in rails.

The distinguished medalist, however, has not confined his investigations to but one branch of engineering; his vision has reached into several divisions. One is the hydraulics laboratory at the university where he has installed turbines, meters, pumps, tanks and gages for research work in water power and measurement. Many of the devices are of his own design.

Testing of materials is another department in which Dr. Talbot has done notable work. Most of his technical accomplishments have materialized since he returned to the University of Illinois four years after graduation in 1881 to become a member of the faculty. A wide variety of engineering subjects, among which are theoretical and applied mechanics, engineering drawing and others, have been taught by him.

INDICATIVE of the recognition Fred H. Dorner has achieved in the engineering profession is his recent nomination as vice president of the American Society of Mechanical Engineers. His enviable engineering record goes back to his graduation from the University of Wisconsin in 1905 with a degree in mechanical engineering. It was then that he began full time employment with Allis-Chalmers Mfg. Co., having spent his summers there while at the university. Two years later he took full charge of the design of steam engines and refrigerating machinery at the Bailey Mfg. Co., Milwaukee.

In 1912 Mr. Dorner joined the staff of the Power Improvement Co., remaining there for several years. Upon leaving this company he went into business for himself and established a sales engineering office which is the largest of its kind in the state of Wisconsin at the present time. Mr. Dorner became a junior member of the American Society of Mechanical Engineers in 1907 and was advanced to member in 1911.

Virtually all his engineering activities have been centered in and around Milwaukee, where he was born in June, 1881. He has been much interested in engineering organizations and was secretary of the Engineers' Society of Milwaukee for 10 consecutive years. In 1924, he was made its president and was re-elected in 1925, the only man to hold the office for two terms.

TECHNICAL training coupled with a varied engineering experience qualify Robert M. Gates for his place among the brilliant engineers of today. He now is vice president of the Superheater Co., New York, and recently was nominated for vice president of the Americal Society of Mechanical Engineers.

O'Brien county, Iowa, was the place of his birth on Sept. 7, 1883. After obtaining his early education in St. Louis and Indianapolis, he entered Purdue university, graduating in 1907 with a degree in mechanical engineering. Upon leaving school he was engaged in railway engineering, subsequently serving in the engineering and costs department of the Browning Engineering Co., Cleveland.

In 1910 Mr. Gates became associated with C. O. Bartlett & Snow Co., Cleveland, where machinery was built under his design and supervision. Three years later he became a partner of James H. Herron in the same city and devoted his attention to engineering and sales work. Later he affiliated himself with the Thew Shovel Co., Lorain, O., and after that with the Lakewood Engineering Co. His connection with the Superheater Co. dates back to 1922, since which time he has been in charge of its technical and sales activities.

DIVERSIFIED engineering activities have performed an important part of the preparation of J. S. Tritle for his new position as vice president and general manager in charge of manufacturing, sales and engineering operations of Westinghouse Electric & Mfg. Co. In this capacity he will be in full charge of all design activities.

Mr. Tritle was born in Virginia City, Nev., in

Leaders in Design, Engineering and Research

A. N. TALBOT

F. H. DORNER

R. M. GATES

J. S. TRITLE

1872 but moved with his parents in early youth to New Haven, Conn. There he obtained his preliminary education, after which he entered Yale university. Two years after his graduation in 1895 with a degree in science, he became connected with the electrical contracting business. In 1915 he joined Westinghouse and in 1925 as general manager of the merchandising department he was overseer of engineering and manufacturing as well as sales work, with headquarters at Mansfield, O.

From that city he moved to the East Pittsburgh plant in 1929, when he was made vice president in charge of manufacturing operations. Mr. Tritle will retain the latter place as his headquarters.

* * *

Dr. Harold B. Smith, for 35 years head of the department of electrical engineering at Worcester Polytechnic Institute, has retired. One of the best known figures in engineering and educational circles, he served as president of the American Institute of Electrical Engineers in 1929. He plans to take an extended rest before resuming professional practice. Prof. Joseph O. Phelon also retired from the electrical engineering department at Worcester in June, following 44 years of service at the institute.

* * *

Roy V. Wright, president of the American Society of Mechanical Engineers and editor for Simmons-Boardman Publishing Co., was recipient of an honorary degree of doctor of engineering conferred upon him at the recent fifty-ninth annual commencement exercises of Stevens Institute of Technology. Dr. Wright's picture and biographical sketch appeared in the July, 1930, issue of MACHINE DESIGN.

* * *

Harvey H. Jordon, professor and head of general engineering drawing and assistant dean, college of engineering, University of Illinois, and D. S. Anderson, dean, college of engineering, Tulane university, New Orleans, La., were elected vice presidents of the Society for the Promotion of Engineering education at the thirty-ninth annual meeting held recently at Purdue university, Lafayette, Ind.

* * *

E. A. Thumbert, who recently was connected with the Palmer-Bee Co., Detroit, as special sales engineer in charge of design and sale of skip hoists and ash hoppers, has become affiliated with Fairfield Engineering Co., Marion, O. He will specialize in the design and sale of skip hoists for coal and ashes, ash hoppers and gates. Mr. Thumbert has specialized in skip hoist engineering and sales work for the past 20 years.

* * *

R. C. Rolfing has been made general works manager of the Grigsby-Grunow Co., Chicago, radios and mechanical refrigerators, succeeding Albert Weiland, resigned. Mr. Rolfing formerly was vice president and general works manager in charge of engineering, and manufacturing for the Hart-Parr Co., Charles City, Iowa.

* * *

W. C. Mander, for many years associated with the Nordyke & Marmon Co., Indianapolis, as chief engineer, has been appointed sales and milling engineer for the flour mill machinery department, Allis-Chalmers Manufacturing Co., to succeed the late James Forrest.

* * *

Charles G. Garrard, Thorn, England, recently was awarded the Edward Longstreth medal of the Franklin Institute for his invention of a speed reducer. The Garrard reducer is of the adhesion type with hardened steel rollers rolling in contact with one another in a bath of oil.

* * *

G. D. Spackman, president of Lukenweld Inc., subsidiary of Lukens Steel Co., Coatesville, Pa., has been appointed chairman of the American Welding society's committee on the use of welded steel parts for the construction of machinery.

* * *

Thomas J. Little Jr., former president of Society of Automotive Engineers, and executive engineer with Lincoln and Marmon, has severed his connection with Holley Carburetor Co., after completing an 18 months' contract.

* * *

Eric H. Ewertz recently was awarded the Samuel Wylie Miller medal by American Welding society for his pioneering in the development and application of arc welding.

* * *

Carl A. Johnson, president of Gisholt Machine Co., Madison, Wis., has been made chairman of the department of manufacture of the United States Chamber of Commerce.

* * *

Dr. Edwin Fitch Northrup, research physicist, has been awarded the Edward Goodrich Acheson medal for 1931 by the Electrochemical Society. He is noted for his work in the development of new methods and instruments for production and measurement of high temperatures,

including the Ajax-Northrup high frequency induction furnace.

* * *

Frank D. Chase, consulting engineer, Chicago, has been elected president of the Western Society of Engineers.

* * *

John J. Baum, of the Development Engineering department of the Steel Founders' Society of America, New York, no longer is connected with that organization. His future plans remain unannounced.

* * *

O. Milne, chief engineer of Peabody Ltd., recently arrived from the Peabody Engineering Corp. office in London where he has been studying foreign conditions for the past year. After spending a short time in this country he will go back to London to continue his work there.

* * *

David E. Ross, formerly vice-president and general manager of Ross Gear & Tool Co., Lafayette, Ind., has been elected president to succeed Edward A. Ross, who died July 10, in London, England. The new president four years ago resigned as vice president and general manager to give his time to research work at Purdue university, of which he is a trustee.

* * *

M. C. Terry has been appointed chief refrigeration engineer of the Westinghouse Electric & Mfg. Co., with headquarters at East Springfield, Mass. He started with the Westinghouse Co. in 1919 and the following year became a member of the research department at the South Philadelphia works. Since that time he has been specializing in refrigeration engineering work.

* * *

Calvin W. Rice, secretary of the American Society of Mechanical Engineers, was among those to receive an honorary award at the recent seventy-fifth anniversary meeting of the Verein Deutscher Ingenieure. The award consisted of a silver plaquette engraved to commemorate the founding of the V. D. I. at Alexisbad in 1856. Dr. Rice was the official representative of the American Society of Mechanical Engineers at the seventy-fifth anniversary meeting, in Cologne.

* * *

Prof. S. W. Dudley, Strathcona professor of mechanical engineering and chairman of the mechanical engineering department, Yale university, has rejoined the engineering organization of Westinghouse Air Brake Co., Wilmerding, Pa., in an advisory capacity. He will be assistant to the vice president and will retain his university connections. He entered the employ of Westinghouse Air Brake as special apprentice in 1905 and became chief engineer in 1914, which position he retained until 1921, when he returned to become professor at Yale.

* * *

Dr. Dorsey A. Lyon, director of the engineering experiment station at the University of Utah, was elected president of the Utah Society of Engineers at the recent annual meeting of the organization in Salt Lake City.

Qualifications Required in Selection of Design Engineers

APPARATUS design yields success with great ease to the man with ingenuity. If the faculty of devising ingenious parts or motions or other features is tempered by patience and persistence it seems that the man generally grows quickly out of the one subject or work he has been following. Such were among the contentions brought out by Edwin H. Brown in a paper presented at the recent Purdue meeting of the Society for the Promotion of Engineering Education. Other points in Mr. Brown's paper follow.

Design analysis apparently finds its successful men in those having a reasonable command of applied mathematical laws, the quality of studious attention to references that have been published and originality in analytical thinking.

Apparatus design demands a knowledge of applied draftsmanship. The American university graduate generally is without great training in this subject and acquires it only by starting at the very bottom in the drafting room. It also requires mastery of the application of the formulas of mechanics, kinematics, flow of heat and flow of fluids which generally is learned in practice and not in the classroom.

It would be of great value to apparatus design if academic training could be given in the limitations to practical success that are imposed by manufacturing processes in the steel mill, pattern shop, foundry, machine shop and fabricating or assembly plant. If it were possible to instruct the American engineering student in these practical subjects some of the aversion to work in the drafting room might be removed and his excellent training in other phases of engineering made more available for apparatus design. It may even be said that at present the general rule is that selection of men for this work requires working experience, regardless of education, for any position but that of detail beginner.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

CAPTURED by simple devices of mechanical and electrical features, a new source of power, which promises a new and practically unlimited market for steel, is announced by Nikola Tesla, whose work as an inventor in the electrical and related fields has made his name known the world over. On the occasion of his seventy-fifth birthday he made the announcement that he was working on the development of this power innovation.

"I have turned for power to a source to which no previous scientist has turned, to the best of my knowledge," he said. "It will throw light on many puzzling phenomena of the cosmos and may prove also of great industrial value, particularly in creating a new and virtually unlimited market for steel."

While he would not reveal anything as to the source from which he is seeking this unlimited power he asserted the supply will be constant day and night at all times of the year. While at first the cost may be too high Mr. Tesla thinks this obstacle eventually will be overcome.

* * *

Patent Office Completes Record Year

THERE is significance in the fact that more cases were handled by the United States patent office in the fiscal year ending June 30, 1931, than in any year in history. While a total of 92,203 applications awaited action on June 30, yet this was a reduction of 27,000 from the number awaiting action one year before. Although some of this expediency in patent action is credited to increased efficiency, it also is due to the employment of 110 additional examiners authorized by congress.

* * *

Tour of Research Laboratories Is Planned

UNDER the sponsorship of the National Research council, a trip is being organized on which executives of various branches of the metal industries, steel, brass, iron and copper, will be members of a party to tour research laboratories this fall. The occasion has been scheduled for Oct. 5 to 15 and was conceived to acquaint the group with scientific research activities now carried on by all classes of industry.

In announcing this, particular note is made of the importance of scientific research in this period of changing economic conditions, looking to such factors in business readjustment as creation of new products and the development of new markets. Details of the tour are being worked out by Maurice Holland, director of the National Research council. Fourteen additional laboratories have been chosen for this year's event. Scientific work being done in many of the laboratories selected for the 1931 tour will have a special appeal to engineers because of the type of work in which some of these institutions specialize.

* * *

Possesses Largest Engineering Library

THE largest strictly engineering library in America is to be found in the Engineering Societies library at 29 West Thirty-ninth street, New York. It contains 150,000 volumes and serves probably 50,000 engineers of all nations annually, H. W. Craver, the director, says.

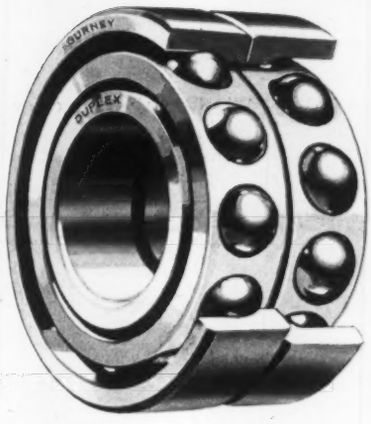
It provides service to all engineers around the globe; all they have to do is ask for it. In the past year inquiries came to the library from 48 states and 34 foreign countries, and in response to orders 46,000 photoprints were made. Replies to questions are sent by letter, cable, wire, telephone, and air mail. Technical articles and pamphlets are translated into many languages.

* * *

Brown Institutes Machine Design Course

IN ORDER to extend the work given in its apprenticeship course to drafting employes, Brown & Sharpe Mfg. Co., Providence, R. I., suggested to the engineering department of Brown university some two years ago that a special course in machine design be included with the various extension courses offered by the university. Resulting from this was a two year course in machine design laid out from a purely analytical standpoint so that only problems of this nature were considered.

The course was made available to men having the required preliminary work whether or not they were employes of Brown & Sharpe. This



GURNEY "HIGH-SPEED" Duplex Ball Bearings - *for* Spindles that run 10,000 *to* 50,000 r.p.m.

The Gurney "high-speed" Duplex was developed especially for extreme spindle speeds. The ball retainers of this bearing are manufactured from a Bakelite bonded material with fine linen base, carefully designed for correct grain structure and treated to prevent distortion during high-speed operation.

New high standards of concentricity guaranteeing inner race eccentricity of .0001" or less are secured through precision workmanship and recently developed improvements in methods of grinding.

Gurney "high-speed" Duplex Ball Bearings are manufactured in pairs . . . carefully matched and balanced to take an equal load distribution under very large spring pressures.

Complete information on this super-accurate high-speed bearing is available to interested manufacturers through the Gurney Engineering Department.

GURNEY BALL BEARING DIVISION
Marlin-Rockwell Corporation *Jamestown, N. Y.*

FEATURES
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HIGH SPEED . . .
10,000 to 50,000 R.P.M. depending on bearing size.

LONG LIFE . . .
2 to 5 years operation in high speed service.

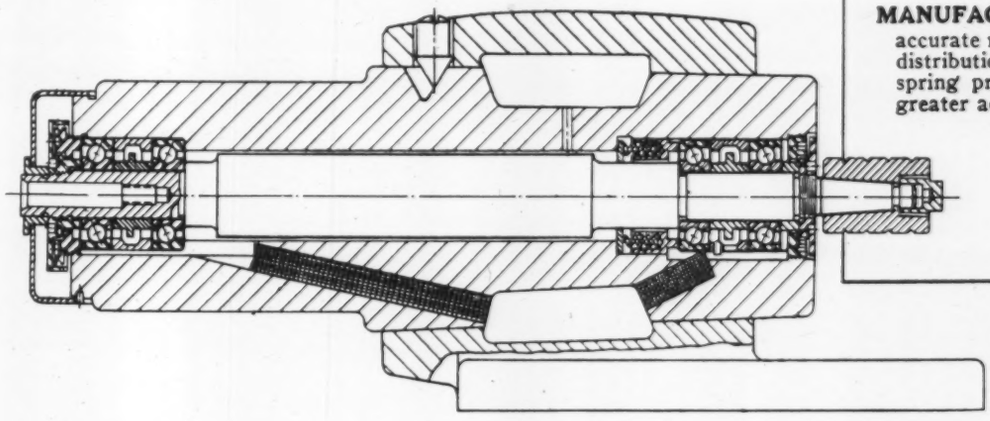
MAINTAINED ACCURACY . . .
Smooth, accurate finish at all times.

SPECIAL RETAINER . . .
Fine linen base, Bakelite bonded . . . takes a high polish reducing bearing wear . . . one piece construction . . . milled ball pockets . . . accurately balanced.

NEW HIGH-PRECISION STANDARDS . . .
eccentricity tolerances of .0001" on inner race.

AUTOMATIC TAKE-UP . . .
bearings are held in adjustment by a series of tension springs.

MANUFACTURED IN PAIRS . . .
accurate matching gives equal load distribution permitting very large spring pressures, greater rigidity, greater accuracy.



GURNEY BALL BEARINGS

company, however, reimbursed its employees who took the course to the extent of half the tuition. Results have been highly satisfactory, and are indicative of the possibilities of co-ordination between industry and engineering schools.

* * *

Economical Patent Plan Is Suggested

IN a recent report of the patents committee of the American Engineering council the establishment of a single court of patent appeals is proposed. Such a court, it is believed, would protect both the patentee and the public from the enormous financial waste incident to the present procedure in obtaining a patent. This court of patent appeals, sitting at Washington, would have final jurisdiction of all appeals from the district courts of the United States and the supreme court in the District of Columbia. The patents committee is headed by Edwin J. Prindle, former president of the New York Patent Law association.

* * *

Contributes to Engineering Foundation

A SUM of $250,000 has been added by Ambrose Swasey to his previous gifts to the Engineering Foundation, which he founded, bringing his total contributions to three-quarters of a million dollars. The gift was announced at a recent dinner in New York, attended by many nationally prominent engineers. He stipulates that the money shall be used "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind."

Mr. Swasey, whose picture and biographical sketch appeared in the June 1930 issue of MACHINE DESIGN, is the surviving founder of the firm of Warner & Swasey Co., Cleveland. The Engineering Foundation was conceived in 1914 on the basis of his conception of a research instrumentality. It was established by the national societies of mining and metallurgical, mechanical, electrical and civil engineers.

* * *

1930 Machinery Exports Show Large Gain

METALWORKING machinery exports from the United States in 1930 amounted to $41,945,398, an increase of about 3 per cent over the imposing figure of the previous year. This amount exceeds that of 1928 by 23 per cent and is 240 per cent above that of 1922. Exports of this class of machinery in 1930 were even greater than in any year since the abnormal postwar year of 1920, according to the industrial machinery division, department of commerce, Washington.

Although extremely depressed business conditions prevailed this record was established, indicating the splendid reputation American manufacturers enjoy abroad. Since 1923 Europe has consumed annually more than 50 per cent of American exports of metalworking machinery despite the fact that manufacturers of similar equipment in the more highly industrialized nations of that area have been striving constantly to expand their export business through lower prices and long-term credits often supported by government guarantees. The progress which the United States is making in this highly technical trade is a tribute to American engineering.

* * *

Engineering Seen As Aid in Depression

ADDED impetus has been given to engineering by the business depression of the last year. With production and sales down, engineering has been called upon to put forth unusual effort toward perfecting products, H. T. Woolson, chief engineer of the Chrysler Corp., told the Canadian Section of the Society of Automotive Engineers recently.

The automotive industry of today has a place in its rank for scientists and technicians in the fields of acoustics, electricity, chemistry, metallurgy, and even radio—the most recent addition to its line of effort. I like to think of the engineering department as scouting and reconnoitering parties going on ahead as research men delving into the many wide areas in the search for something new and radical, Mr. Woolson declared.

Subsequent constructions will demonstrate that the present depression has not been an unmixed evil when consideration is given to the numerous improvements that will have resulted from it.

* * *

Makes Technical Survey of Libraries

TECHNICAL library facilities throughout New England are adequate on the whole to meet requirements of engineers, although foreign books and periodicals are decidedly lacking and in many libraries technical literature needs weeding out. These facts are reported by Julian A. Sohon, chief bibliographer, Engineering Societies library, New York, who surveyed public, university and industrial organization libraries in 25 cities and interviewed 46 prominent engineers.

The purpose of the survey was to determine how far the public library meets the requirements of technical literature and to obtain suggestions for extending the work of the Engineering Societies library. Mr. Sohon reported that librarians suffer from a lack of technically trained assistants and from inability to judge advisability of purchasing certain engineering books.

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IN THE Rock Products Industry, heavy production schedules are accompanied by imperative demands for continuous operation and capacity output. Equipment must not give way under the peak load. This brings out clearly the necessity of Alloy Steel for important parts.

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NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

VARIABLE speed is obtained in an unusual manner by an interestingly designed driving mechanism recently granted, patent No. 1,809,469. The invention relates particularly to a device for rotating the main shaft of weaving looms, by which shaft an alternating motion is imparted to the lathe (lay, batten) in such a manner that from the middle position it is moved at a higher speed forward than backward.

Constructional details of the mechanism are shown in the three views *A*, *B* and *C* of Fig. 1. On shaft 1, which is to be rotated at varying angular speed and which may, for instance, be the main shaft of a weaving loom, an arm 2 is idly mounted. This arm is connected to the pulley 3 which is driven at constant speed. Adjacent to the arm 2 another arm 5 is secured rigidly to the shaft by key 4. On hub 6 of this second arm 5 an eccentric 7 is mounted which is provided with an extension 8 journaled to the machine by rod 8a, thus being prevented from turning with the shaft 1. A third arm 9 is mounted on the eccentric 7 so as to turn idly on it.

In both arms 2 and 5, slots 10 and 11, respectively of curved form and inclined in opposite directions, are provided. The radius of curvature of both of these slots decreases with the distance from the shaft, that is to say, the outer parts of the slots are less curved than those nearer the shaft. The third arm 9 has a straight slot 12 extending in a radial direction. Pin 13 extends through the slots 10 and 11 and is adjustably fastened in the slot 12 by means of nut 14.

Acceleration of the arm keyed to the shaft during one-half the turning of the idle arm, and its retardation during the other half, is effected by the co-action of the pin and slots. If the pin crosswise to its own axis and that of the shaft, is shifted in the one direction, the driven arm will be caused to lead in advance of the driving arm. This is because the action of the pin sliding on the one side wall of the slot constitutes an inclined plane. The oscillating movement of the pin in the reverse direction causes the driven arm to turn behind the driving arm. By changing the inclination of the slots the degree of leading and retarding effect can be varied accordingly.

Friedrich Brock, Vienna, Austria, is the inventor and Tannwalder Baumwoll-Spinnfabrick, Tannwald, Czechoslovakia, assignee.

IMPROVEMENTS in the construction of centrifugal hammers are provided by a recent invention which embodies an impact device of new design. The patent, which has been designated No. 1,812,692, covers centrifugal hammers in which the cam and rolling track upon which the impact member travels during rotation are formed integral or in one piece.

Position of the parts at the moment of impact is illustrated in Fig. 2 *A; B* is a section on line II-II of *A*, the parts shown being in the position occupied immediately before release of the ball

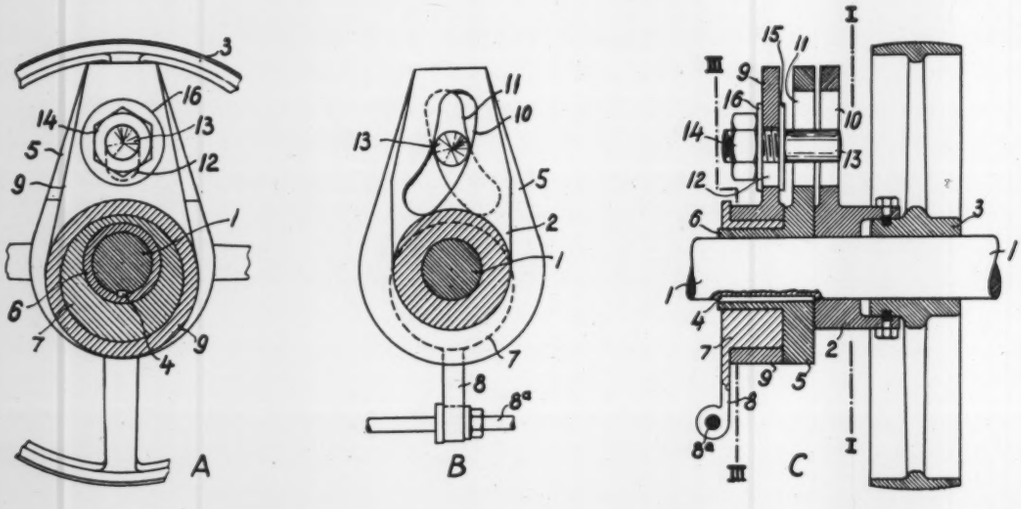
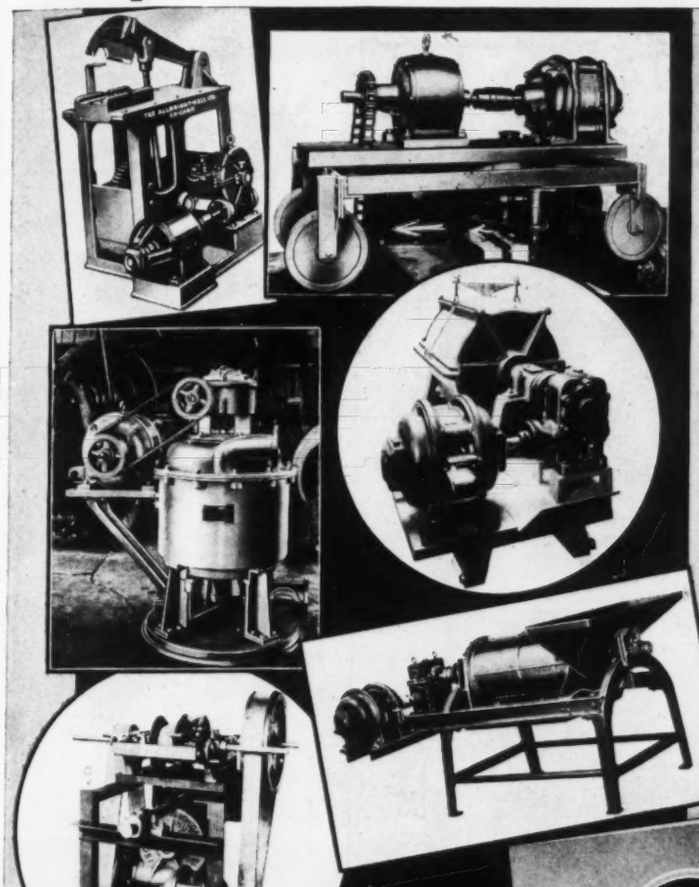


Fig. 1 — Three views of driving mechanism for rotating shafts at variable speed. The degree of retardation and acceleration of arm 5 depends upon the curved form of slots 10 and 11

Why Not Profit From the Experience of Industrial Leaders?



ONLY A FEW OF THOUSANDS OF SUCCESSFUL APPLICATIONS —

Leading Equipment Manufacturers in every industrial field desiring to incorporate simplicity, durability, and precision performance into the drive of their products have enhanced the sales value of their product by standardizing on IXL Speed Reducers.

Embodied in IXL Reducers is the best that engineering skill, precision manufacturing methods, and carefully selected materials can produce. Their design is based on a careful study of the requirements in various industrial fields, backed by a thorough knowledge of speed reducer design and manufacture gained over a period of thirty years.

IXL Speed Reducers are made in Spur, Worm, Helical, and Herringbone Types for horizontal, vertical, or right angle drives---fractional H. P. up to 300 H. P. and reduction ratios from 2 to 1 up to 50000 to 1. There's a size and type for every possible requirement.

Let our Engineers figure on your requirements. Helpful and instructive data sheets for requesting recommendations sent on request.

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GEAR AND MACHINE CO.
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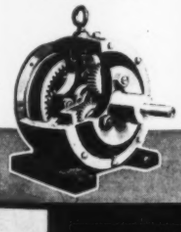
Sales and Engineering Representatives in every important city of the U. S. A. and Canada.—

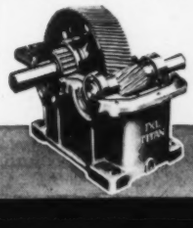
Send for the latest Foote Bros. Data Book on IXL HYGRADE Worm Reducers chock full of invaluable information on worm gear evolution, design, and applications with data, tables, formulae curves, problems, etc.

USE THE COUPON

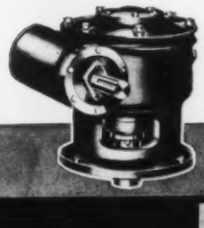
IXL SPUR GEAR REDUCER



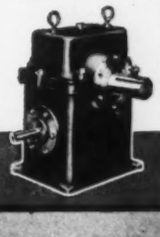
IXL SINGLE REDUCTION HELICAL REDUCER



IXL HYGRADE VERTICAL REDUCER



IXL HYGRADE WORM REDUCER



MD 306

Foote Bros. Gear and Machine Co.
215 N. Curtis St Dept. 67
Chicago, Ill.

The IXL HYGRADE Worm Gear Speed Reducer Handbook will be sent without cost to any executive or engineer in U. S. A., Canada or Mexico.

Name _____

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_____

8-31

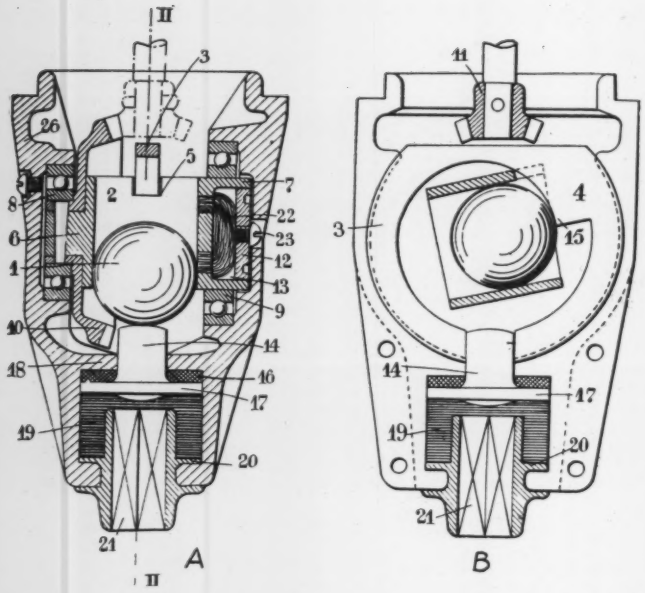


Fig. 2—Centrifugal hammer, A showing position of parts at moment of impact; B is position immediately before release of impact device by cam

or impact device by the cam. Ball 1 is freely movable longitudinally in a driving socket or sleeve 2. Slot or opening 5 in the driving socket straddles the rolling track and cam during rotation.

In operation the ball 1 moves outward under the action of centrifugal force so that it runs on the rolling tracks 3. The cam forces the rolling mass radially inward against the centrifugal force until it reaches the point 15 of the cam. There it suddenly is released to strike a blow upon the anvil or like member 14 which transmits to the tool the blows received. Movement of the anvil may be dampened or cushioned by washer 16 placed between the flange 17 and the shoulder 18 of the casing. The same effect also is obtained by a number of washers 19 formed of fiber, metal or other suitable material and clamped between the flange 17 and flange 20 of the tool carrying member.

Washer 16 opposes tightening or drawing together of the shoulder 18, which if allowed to take place would cause a binding of the anvil in the casing. Moreover, the arrangement of the washers 16 and 19 deadens the vibrations produced by blows of the impact member.

The improvements to centrifugal hammers as outlined in the foregoing were conceived by Nicolas Georgevitch, Paris, France, and assigned to Joseph A. Dahme.

A SYSTEM comprising centralized means for supplying lubricant to a number of bearings has been devised by C. A. Hanson, Chicago, and approved by the patent office. It bears patent No. 1,803,703 and has been assigned to Alemite Corp., Chicago. One of the interesting claims covers automatic compensation for differences in the resistance of the various bearings to entry of lubricant. High pressure is maintained by the system on a bearing of high resistance and vice versa, all independent of and without disturbance to the apportioning means.

The apportioning unit is shown at *A* Fig. 3, and the supply device at *B*. When each pressure impulse arrives through conduit 32, the check valve 50 opens and cup 56 moves down as shown in *A*, Fig. 3. During this movement a predetermined charge will pass through the exit 66. After the lower edge of cup 56 is seated on the shoulder 64, the check valve 50 will close, and after the pressure impulse ceases, the spring 60 slowly returns the cup to the upper seat 62. During this movement a charge equal to that delivered to the exit passage 66 will pass through the clearance 58 for delivery on the next pressure impulse.

If the amount of lubricant delivered on each operation is not immediately absorbed by the bearing the excess will compress the air inside cup 56, moving cup 68 up. In this way, a high resistance will force the cup 68 well up into cup 56, generating a pressure which will be maintained on the bearing throughout the periods between the pressure impulses.

A bearing of less resistance will maintain a considerably smaller reserve stored in the cup 56 and receive its share at materially lower pressure. Both classes of bearings will receive the proper amount of lubricant and the pressure automatically will adjust itself to that point necessary to force lubricant into each bearing.

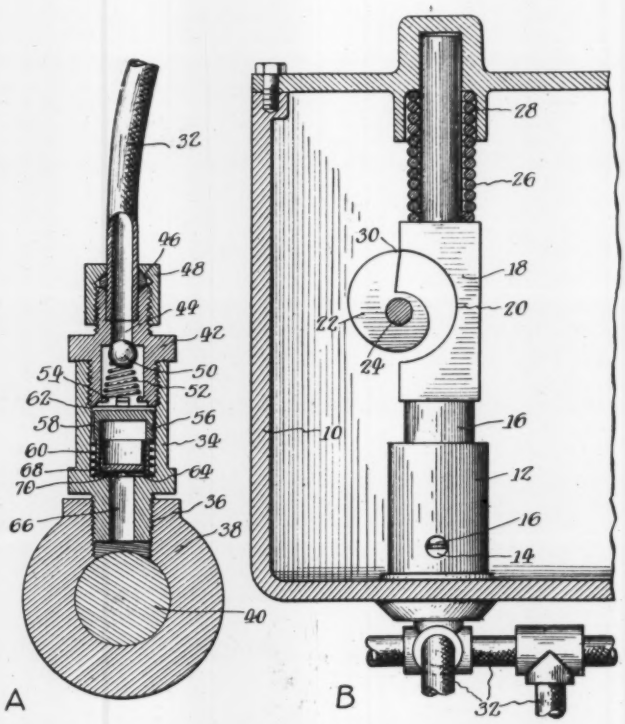
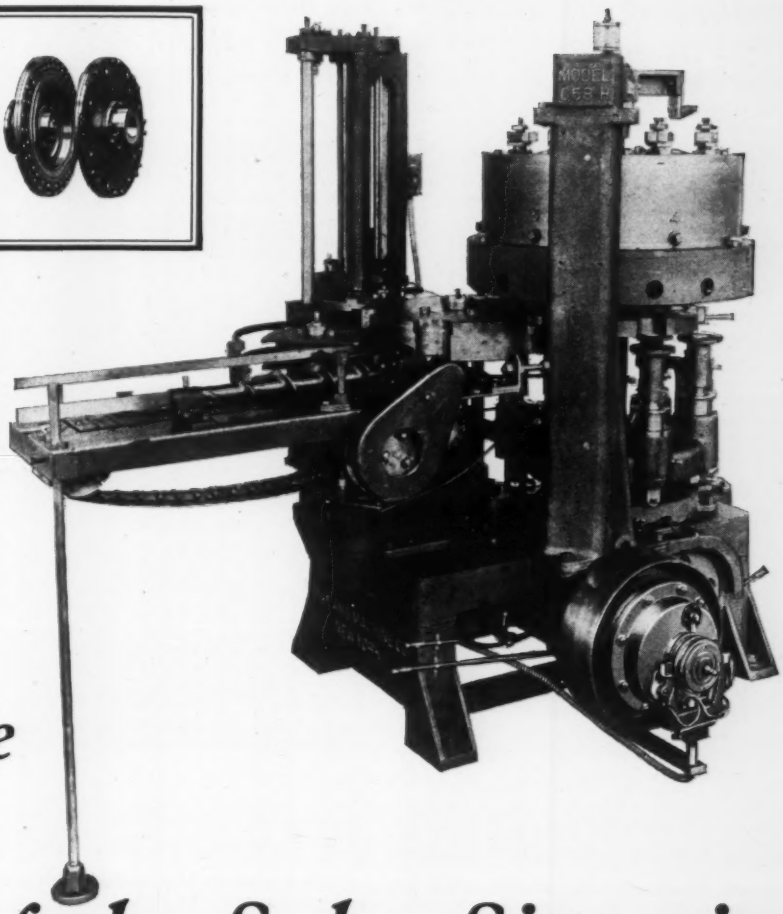


Fig. 3—A is a section through apportioning device of lubrication system; B shows supply unit

C-H Magnetic Clutches consist simply of two plates. They are engaged by magnetism, pressure being self-contained. Engagement of driven member with driving member running at full speed is smooth, jerkless, without grab or bounce, without shock to equipment.

Just off the press!

If you would keep ahead of your competition in machine design, read this new book. Contains complete revised data on magnetic clutch application. Sent promptly on all requests received on business letterheads. Ask for CL-7, "*Keeping Pace With Machine Design.*"



For a better machine ... and command of the Sales Situation

WITH more than 3 million horse power now being served by C-H Magnetic Clutches, you're not pursuing a "will o' the wisp" when you investigate these clutches to see what they can do for your machine . . . *and for sales!*

It is hard to say where C-H Magnetic Clutches won't fit in . . . with their flexibility of application, their possibilities of remote and automatic control, the elimination of unnecessary parts, the reduction of power wastes and hand or machine operations.

C-H Magnetic Clutches are simple . . . consist only of two members. These members are engaged and disengaged by magnetism. The only part to wear is the friction lining; it serves a long time and it is most easy to replace. The clutch is engaged by push-button, foot-pedal or automatically by float switch, cam-switch, pressure-switch—any similar device—located where convenience, not necessity, dictates.

The C-H Magnetic Clutch performs any sequence of functions automatically without watching, day in and day out.

It occupies less space than any other type of clutch . . . will help make your design more compact. It is light in weight; positive in engagement. It eliminates off-center weights, end- or side-thrust. It ends the need of back-up parts, toggle-joints, sliding collars, pivoted arms. It provides such smooth grabless clutching that the life of machine and motor is lengthened appreciably . . . and maintenance-costs cut to the minimum.

Fully descriptive of C-H Magnetic Clutches, the booklet CL-7 will be sent upon request without obligation.

CUTLER-HAMMER, Inc.

Pioneer Manufacturers of Electric Control Apparatus

1326 St. Paul Avenue

MILWAUKEE, WISCONSIN

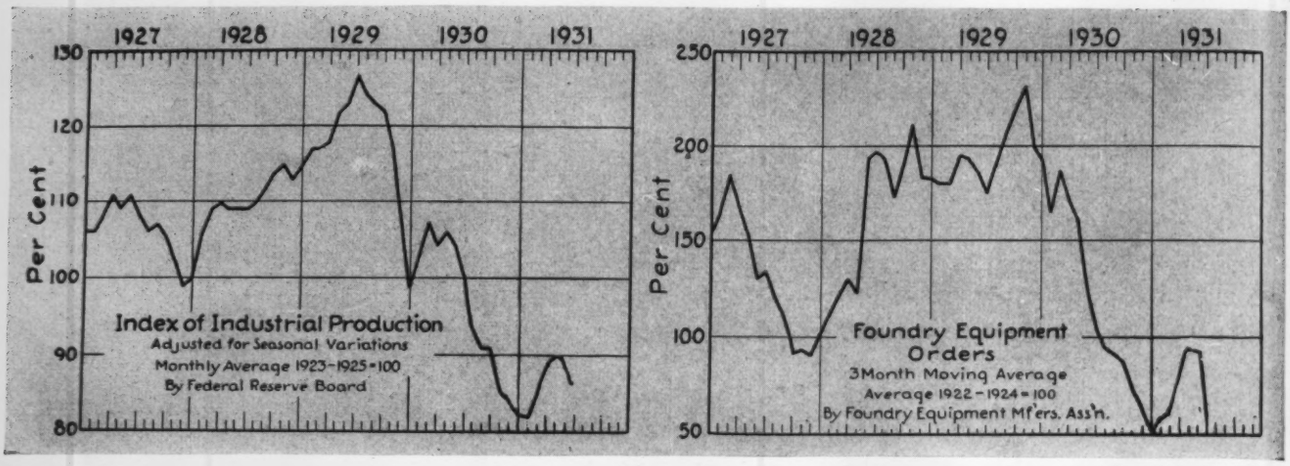
The Amsco Can-Making Machine Above

Requirements of space and safety prompted the Max Ams Machine Co. of Bridgeport, Conn., to equip their Amsco-Six high-speed can-making machines with C-H Magnetic Clutches. The feed would jam if a can top did not register properly or if the can-top magazine was empty. Serious damage might result. This is prevented by the use of C-H Magnetic Clutches. A cam-switch disengages the clutch automatically at the right moment and the machine stops.

CUTLER HAMMER

Magnetic Clutches Save Time and Save Equipment

(A-336)

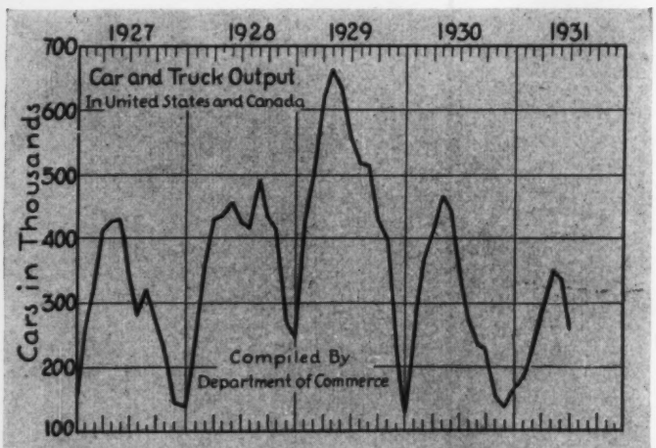


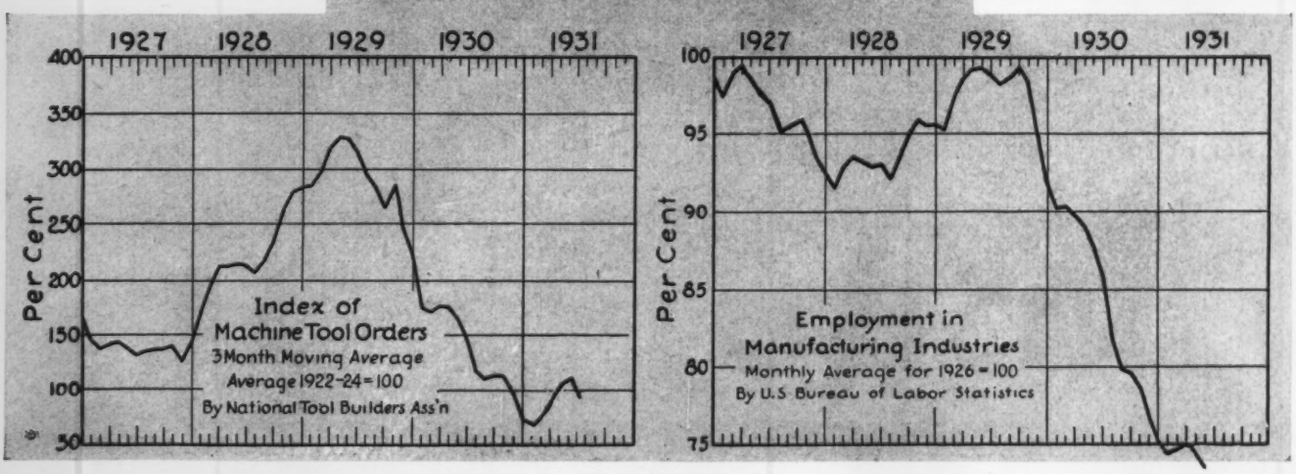
How Is Business?

ALTHOUGH the percentage drop in business activity from May to June 1931 was not as great as that experienced during 1930, the expected decline arrived on schedule and business generally settled down to its summer lethargy. Prospects are for a fair summer with the definite upturn from the depths in which business has been traveling still in the indefinite future.

The one bright star on the horizon is the success that has greeted the appearance of the Plymouth automobile. This one organization exhibiting a pre-depression optimism has stimulated activity in a number of other organizations selling them bodies and parts and stands out as an example of the advisability of placing before the public new improved products at lower cost. These may shade so completely the specter of continued dull months that clotted capital will be returned to circulation.

The world moratorium is expected to create a returned confidence in business possibilities in the fall. This action cannot have an extended effect on total sales as the export business of the United States is only about ten per cent of all business transacted, but its psychological effect will be to cheer up distressed executives and enable them to return to work with renewed confidence. As the total amount of money in the country is unchanged, it is imperative that manufacturers gain this confidence so that they will introduce new products and stimulate design and sales.





BALL BEARINGS

A Typical Installation

A Typical Installation

MADE TO MEET YOUR DIMENSIONS

WE make bearings to suit your own needs. We design and build them to your dimensions. We solve the most difficult bearing problems. In other words, you may obtain "COMMERCIAL" stock bearings for any purpose, or you can have "COMMERCIAL" Bearings made to order.

"COMMERCIAL" Ball Bearings are very moderate in price. Millions of them are used every year in every industry. Tiny bearings, the size of a dime, to large bearings for heavy duty service.

The famous three-point contact. Revolutions up to 2,500 R. P. M. Easily take care of overloads, shocks, strains and side thrusts.

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THE SCHATZ MANUFACTURING CO.
POUGHKEEPSIE, NEW YORK

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THE FEDERAL BEARINGS CO., Inc., POUGHKEEPSIE, N. Y.
Manufacturers of High Grade Precision Annular Ball Bearings

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"Commercial"

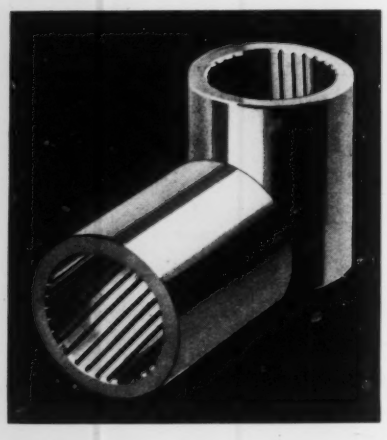
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Bushing Is Self-Lubricated

NEARLY half, 40 to 45 per cent, of the entire bearing surface in the new bronze cast self-lubricating bushing, developed by Johnson Bronze Co., New Castle, Pa., is graphite impregnated. As illustrated, this result is accomplished by cutting dovetailed grooves of approximately 1/32-inch in width into the bearing surface longitudinally on an angle of seven degrees. Spacing these slots closely obtains a mechanical structure almost exactly similar to an alloyed granular structure of a composition of a hard and plastic bearing material.

The company also has developed a new rolled sheet metal bushing that is graphite lined. Grooves are cut into strip metal, and, by forming the metal into cylindrical shape, the grooves automatically form a dovetail which holds the lubricating compound in place permanently. Thus serious injury to the structure of the metal is avoided.

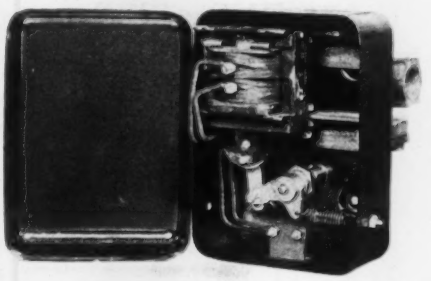


Nearly half of bearing surface in new bronze, cast, self-lubricating bushing is graphite impregnated

Valve Provides Positive Control

POSITIVE control of liquids or gases under pressure is possible with the use of a new solenoid-operated valve, designated CR-9507-A1, developed by General Electric Co., Schenectady, N. Y. Some of the uses for which the valve, shown herewith, is designed are: For controlling the flow of brine through cooling pipes in cold-storage rooms; for remotely or automatically controlling the supply of oil or gas to furnaces; and for controlling the flow of water in cooling jackets on compressors.

The gland connected to the operating mechanism of the valve is of the rotary type reducing the frictional load. The seat and poppet are ground carefully to fit and only materials suitable for use with the liquid or gas to be controlled are used. Valves can be made normally open or normally closed, in the field, by drilling the mounting holes in the case and transferring the solenoid and operating mechanisms to the opposite side. The valves are unbalanced and require little power for operation. A standard solenoid is used. The operating mechanism is so arranged that the solenoid plunger is permitted to accelerate without load for a fraction of the stroke.

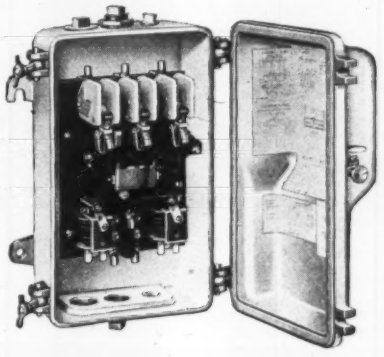


Solenoid-operated valve gives positive control of liquids or gases under pressure

Design Contactors for Relay Work

MADE especially for relay work and similar applications, two new contactors manufactured by Allen-Bradley Co., Milwaukee, are provided with "down" or "back" contacts against which a single pole contactor arm is held when the operating coil is not energized. When the coil is energized the circuit is open. Bulletin 201 Form E (direct current) and Bulletin 701 Form E (alternating current) are two-wire, single pole, up-and-down contactors. They are provided with a double set of single pole sta-

tionary contacts and a double contactor on the contactor arm. The two circuits are insulated from each other, one being normally closed and the other open. When the operating coil is energized, this connection is reversed. This method

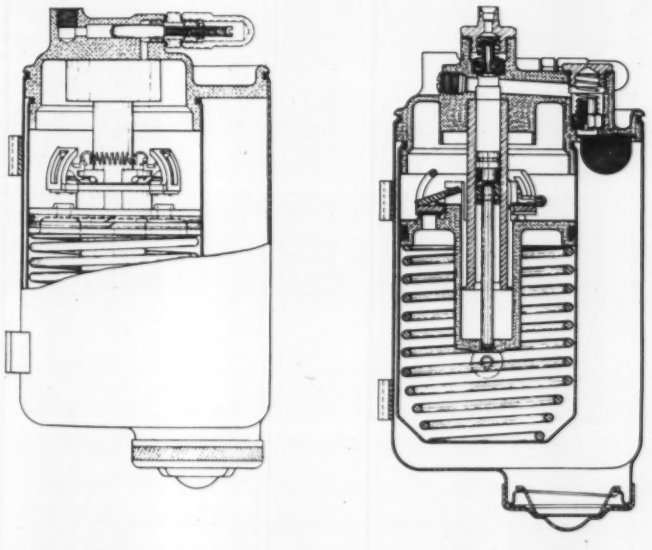


Contactors are built especially for relay work and similar applications

of control is used when the double throw, single pole, magnetic operation for two-wire separate or common control is necessary. The contactors are shown in the accompanying illustration.

Lubricators Operate Automatically

CONTROLLED by operation of the machine on which it is installed, the new Farval type C automatic system of lubrication developed by Lubrication Devices Inc., Battle Creek, Mich., delivers predetermined amounts of oil to every bearing immediately upon starting the machine and cuts off the supply as soon as the machine is shut down. Rate of delivery of lubricant to the



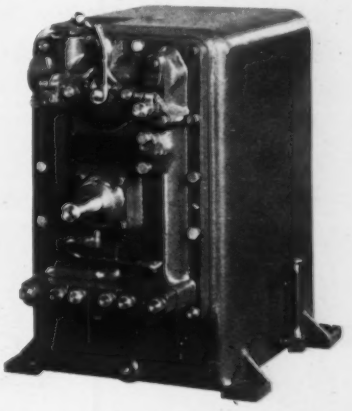
Two views of the compressor unit which operates automatic lubrication system

bearings is not dependent upon the speed of the machine, but is controlled by a simple adjustment provided on the compressor unit. The system of lubrication consists essentially of three parts—the compressor unit, a single main pipe line, and a measuring valve at each bearing.

The operation of the automatic compressor unit, shown in the accompanying illustration, is entirely hydraulic, and a pressure of 20 pounds per square inch or more is the only motive power necessary for "shooting" the system. No cams, levers, toggles, ratchets or gears are required. The compressor unit is self-contained within a one quart reservoir. It is of simple construction with all parts sealed. A measuring valve, operating on the positive piston displacement principle, delivers to the bearing the correct amount of lubricant. The pressure built up in the supply line acts on the valve piston, forcing the measured charge of lubricant into the bearing at high pressure.

Overloading Prevented in New Pumps

OVERLOADING the pump, work and tools is prevented by an internal relief valve which can be adjusted according to the force required, on two new high-pressure pumps, types QR-2 and QWR-2, manufactured by Oilgear Co., Mil-



Internal relief valve on high pressure pumps prevents overloading of pump, work and tools

waukee. At full stroke and load, type RQ-2, shown herewith, is said to have an efficiency of 90 per cent. This one way variable delivery pump delivers a smooth and positive volume of oil under any pressure within the maximum capacity of the unit, which is 15,000 pounds per square inch. The power input is always in direct proportion to force required to perform the operation.

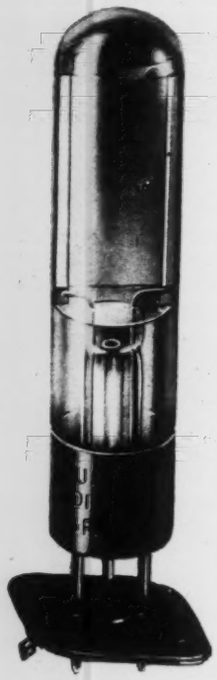
Type QWR-2 one way variable delivery pump is similar in construction and operating characteristics to the type QR-2 pump with the additional feature of a constant and variable pressure control. On applications where it is necessary or desirable to hold work under a predetermined pressure for a period of time, this type is especially suitable because it eliminates overheating and saves power.

The company is also building two new pumps

having a maximum working pressure of 2500 pounds per square inch. The construction, operating characteristics and specifications are the same for the types described in the foregoing.

Radiovisor Bridge Simple and Reliable

SIMPLICITY and reliability brand as unique the radiovisor bridge recently introduced to designers and manufacturers of automatic machinery and controls by Burgess Battery Co., New York. Briefly, the bridge shown in the accompanying illustration, is not unlike the smaller forms of radio tubes, with a tall, thin glass bulb containing the light-sensitive surface. This element consists of a narrow glass plate carrying a pair of interlocking gold combs or grids fused in place and coated with a thin layer of light-sensitive enamel. When the entire light-sensitive surface is eliminated, there is a minimum of inactive material to serve as an inert shunt. The bridge is provided with a three-prong base, two prongs serving as contacts while the third is for positioning purposes. A special three-prong socket is available for the bridge.



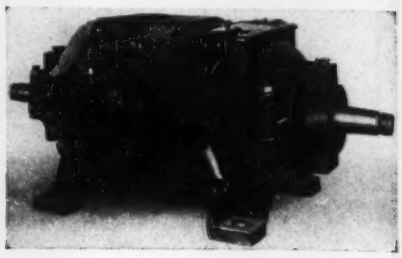
Radiovisor bridge is built for service

With a light to dark resistance ratio of six to one, together with the handling of a considerable flow, the bridge can be employed in the simplest of circuits with a minimum of associated equipment. It will operate a sensitive polarized relay when coupled to a "B" battery of 100 volts or more. It may be coupled to a vacuum tube for the operation of a power relay, which, when provided with a vacuum contact, will handle up to 6 amperes continuously and 8 amperes intermittently at 220 volts. Used with a second tube acting as a rectifier, it may be operated on the usual alternating current supply.

Develop Heavy-Duty Steel Mill Motor

A NEW steel mill motor, designed for heavy duty applications, has been developed through the co-operative efforts of steel mill engineers and the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The design of this motor, shown in the accompanying illustration, embodies the latest suggestions and recommendations of the Association of Iron and Steel Electrical Engineers.

It has many new and distinctive features. The field coils and poles are secured positively to frame without the necessity of washers or springs or other parts liable to become loose and cause damage. The improved bearing housings



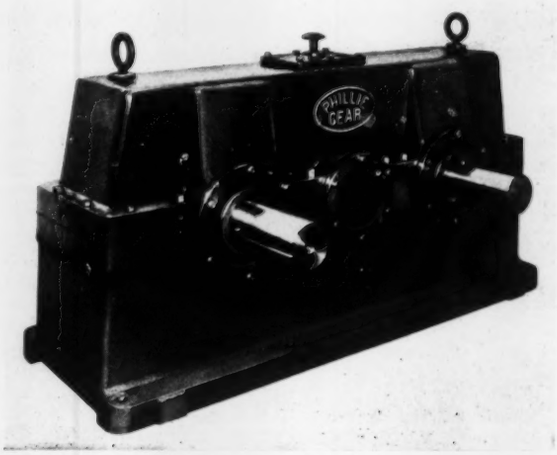
Steel mill motor, designed for heavy duty applications, has many distinctive features

are held securely from turning by a clamp on each side of the housings and accommodate, interchangeably, ball or roller bearings of any standard make for grease or oil lubrication.

Deep commutator bars and wide risers permit many replacings giving added years to commutator life. Laminated commutating poles prevent injurious sparking and give excellent performance, particularly in plugging and reversing. This construction permits high overload capacity without injury to commutator or brushes.

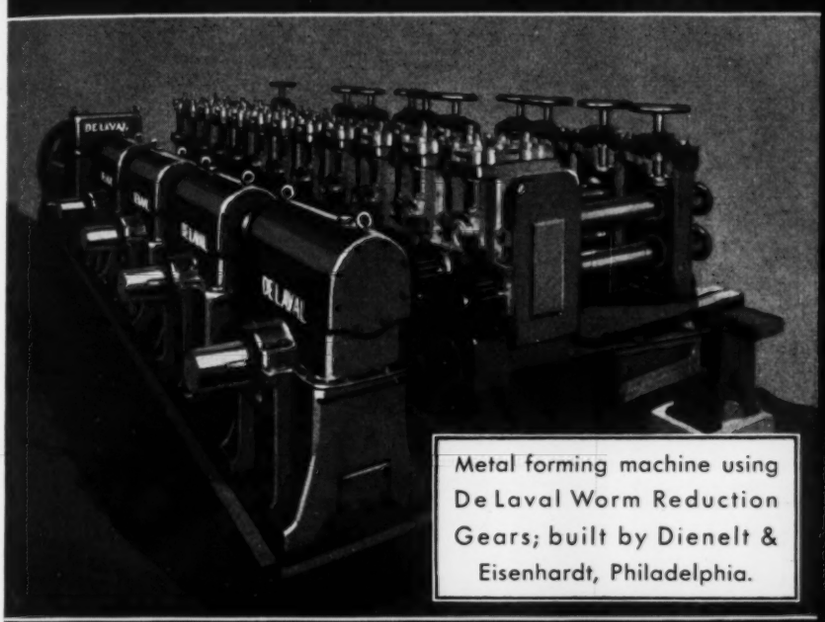
Steel Casings Protect Speed Reducers

WELDED rolled steel casings which protect the unit from accident have been adopted as standard equipment on speed reducers manufactured by Philadelphia Gear Works, Philadelphia. In effect, these reducers, shown herewith, are hermetically sealed vaults, armored against exterior destructive effects. In steel mills or in other strenuous service where a dropped ingot, a



Rolled steel casings protect speed reducers from accident

COMBINE in your machine



Metal forming machine using De Laval Worm Reduction Gears; built by Dienelt & Eisenhardt, Philadelphia.

Durability
Reliability
Compactness
Simplicity
Silence
Smooth Action
Safety
Efficiency
Self-Lubrication

DE LAVAL WORM GEARS

have each and all of these qualities to an exceptional degree.

Worms and gear wheels manufactured on a strict limit gage basis are now available for use in your own machines, or we will supply our standard frames where adaptable. Time and tool charges can be saved by laying in gears on our standard centers, and by using one of our many standard ratios.

Our engineers will gladly assist in applying worm gear drive to your machines.

De Laval Steam Turbine Co., *Trenton, N.J.*

Protect your Product

with **Everlocks**

THE LOCK WASHER THAT IS TOTALLY DIFFERENT AND BETTER

Note uniform length and depth of impressions made in nut by the sharp Everlock teeth. This is a cut of unretouched photograph, and you can demonstrate the biting power of Everlocks in your own plant.

Everlock Washers hold bolts, nuts, and screws with unfailing tenacity. The sharp, hardened teeth bite deep into both the nut and the work—the most severe vibrations only make the teeth bite deeper.

Everlocks are so attractively priced that it's a needless risk to incur hazards by using inferior lock washers or no lock washers at all.

If you could test out Everlocks in your own plant on your own work you would become as enthusiastic about them as we are.

Mail the coupon for free samples and see for yourself how tightly they hold!

Thompson-Bremer & Company,
1640 W. Austin Avenue,
Chicago, Illinois.

We want to test Everlock Washers. Send free samples today.

Name.....

Address.....

swinging beam or contact with other heavy objects might crush the normal casing, these indestructible steel housings protect the mechanisms they contain from violence. All the running parts are sealed in, dust, dirt, moisture, acid fumes and other external dangers are sealed out.

Centrifugal Unit Needs Little Care

DESIGNED to insure good service with but little care and attention, the new Monobloc, Type D, centrifugal unit recently placed on the market by Worthington Pump & Machinery Corp., Harrison, N. J., has a simple and rugged pump bolted to the extended motor frame, the impeller of which is mounted on the end of the continuous motor shaft. The bronze impeller incorporates the shaft sleeve as an integral part. The special cadmium-plated steel locking device for the impeller, the forged bronze packing gland, and the arrangement of shaft water-throwers, are other important features of this pump.

Simple and rugged centrifugal unit is bolted to extended motor frame

The application of this new unit, shown herewith, are many, and it should find a place as a built-in part of assembled equipments such as air conditioning apparatus, dish, bottle, can and metal-parts washing machinery, filters and filter systems, dairy equipment, core sucking units and many others.

Designs Slow Speed Torque Motors

SLOW speed torque motors capable of standing stalled for lengthy periods with the current on are announced for general application by Ohio Electric Mfg. Co., Cleveland. Employment of these units formerly has been restricted largely to the elevator field.

The motors generally are wound for rotation at 600 or 1200 revolutions per minute if not opposed, but they will drive at lower speeds determined by the load, without danger to the motor. They are especially suitable for purposes where

This New Dumore Gear Reduction Unit Provides the Advantages of High Motor Speeds for Low Speed Applications . .

This DUMORE Fractional Horsepower Motor Unit, with speed reduction gear, combines the advantages of light weight and smooth operation of a high speed universal type motor for low speed applications. Combinations varying from approximately 36 to 1, to as high as approximately 1089 to 1, are available.

Reduction gears can be furnished either in bronze or bakelite material. The gear housings may be positioned on the motor case so that the driving shaft will project at any desired angle tangent to the armature shaft.

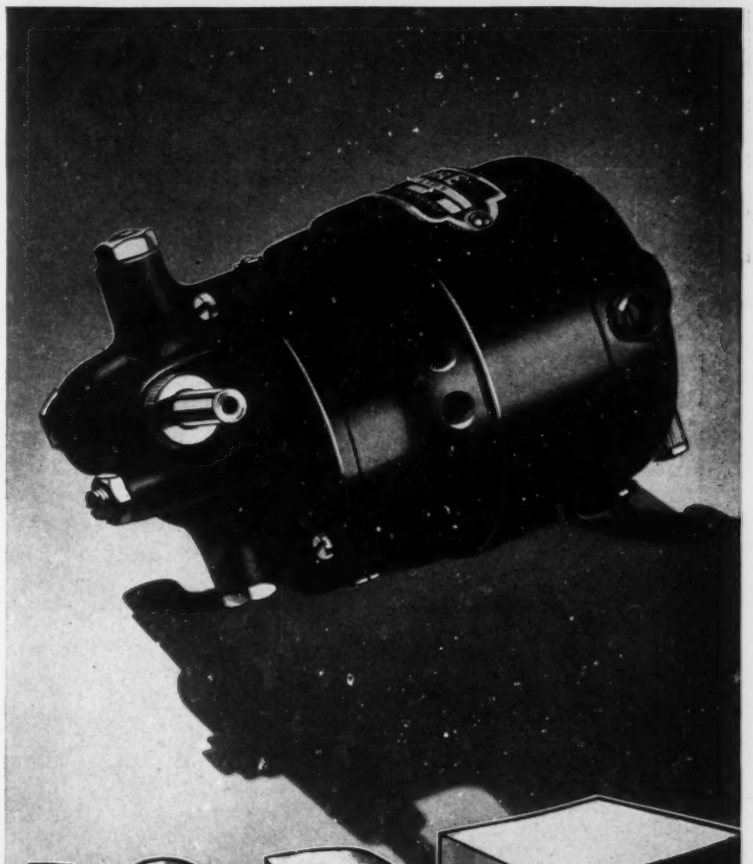
DUMORE motor engineers will cooperate with manufacturers in providing a motor unit for low speed application.

THE DUMORE COMPANY
100 SIXTEENTH STREET RACINE, WISCONSIN

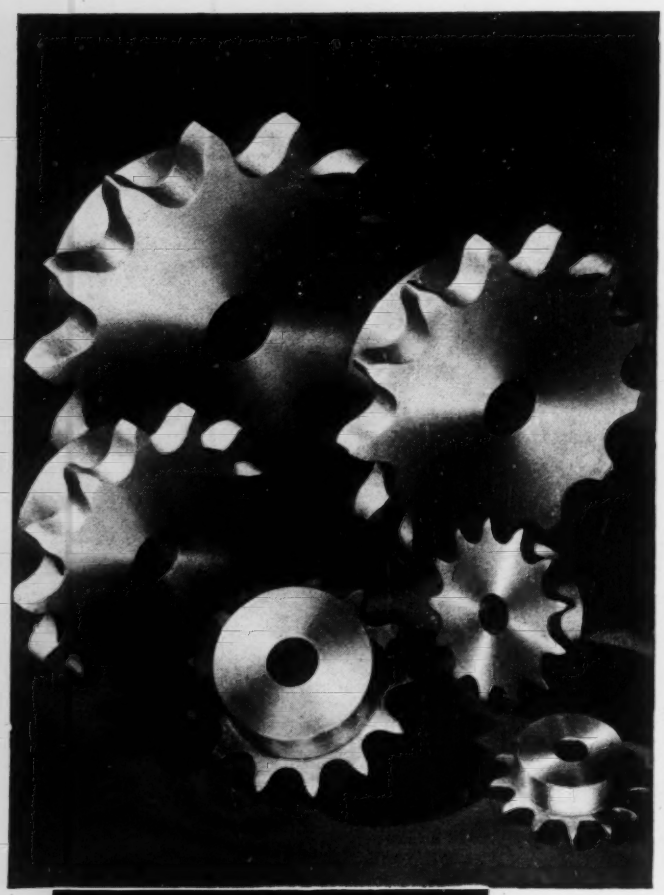
Range of Double Gear Reduction Units

Reduction Unit	Amt. of Double Reduction	Speed of Ext. Shaft R. P. M.
A	1089 — 1*	7.4
F	441 — 1*	18.2
J	289 — 1*	28.0
L	204 — 1*	39.0
O	144 — 1*	56.0
R	72 — 1*	111.0
T	36 — 1*	222.0

Speed of extension shaft based on motor speed of 8000 R.P.M. under load.
*Standard stock motors — other combinations furnished on order.



DUMORE
FRACTIONAL HORSEPOWER MOTORS



SPROCKETS-
THE KEYS TO
CHAIN LIFE

Correct Tooth Design **and** ***Accurate Machining*** **are the major reasons why** ***Baldwin Sprockets*** **actually lengthen the life of your roller chain.**

Baldwin sprocket teeth are as accurately spaced and cut as the teeth of a precision gear. Hub holes are absolutely true, thus eliminating the "wobble" and mis-alignment that cause excessive wear on both sprockets and chains.

Whether you use roller chain for power transmission drives or for conveying, you will find, ***on fair trial,*** **that Baldwin Sprockets will lengthen its life.**

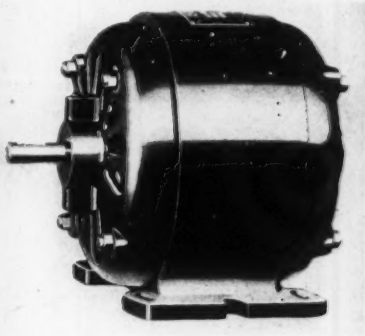
The new booklet—"Baldwin Stock Sprockets with Integral Hubs"—gives complete data on Baldwin Roller Chain Drives—all sizes and ratios. Send today for your copy, addressing the main office or your nearest Baldwin distributor.

BALDWIN-DUCKWORTH CHAIN CORPORATION
Baldwin Division, Worcester, Mass.
Duckworth Division, Springfield, Mass.

BALDWIN
DUCKWORTH

power must be exerted to a standstill such as in the case of valve operation, pumps which operate to maintain a pressure between given limits, or other similar uses.

Each motor is built for the particular job for

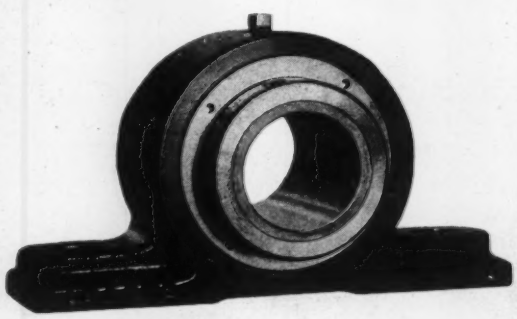


Improved slow speed torque motors are capable of standing stalled with current on for lengthy periods

which it is intended, and may be wound for direct current, polyphase alternating current, or to a limited extent for single phase alternating current.

Roller Bearing Units Are Self-Aligning

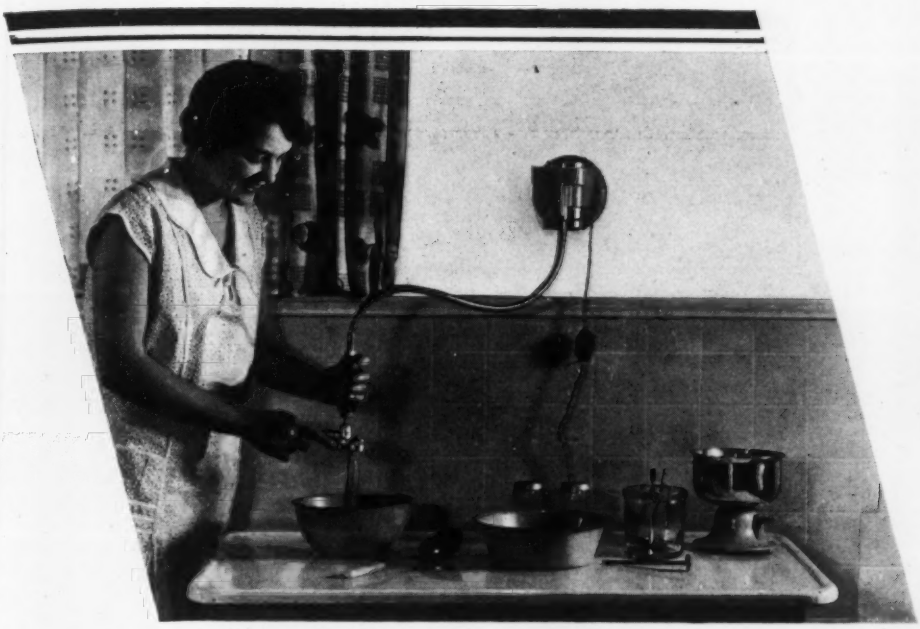
LIGHTER in weight, compact and with simpler housings, an entirely new line of self-aligning roller bearing units for normal duty applications has been introduced by Shafer Bearing Corp., Chicago. The units, one of which is shown herewith, are furnished as pillow blocks, flange units, and take-up units in a full range of shaft sizes from ¾ to 3 inches. The inner race



New roll bearing units compensate for minor inaccuracies in machining or in deflection of shafts

of the bearing is extended on one end only and fastened to the shaft by a special locking collar, providing ample capacity for the intended service and a simplified application of the unit.

The sealing of the normal duty unit is accomplished by a grease seal consisting of two steel stampings pressed into the housing or cover. Between the stampings is a 3/32 fiber washer which is a slip fit on the extended cone. The seal effect-



Meet the Wife-saver!

—a neat, handy, safe, labor-saving kitchen appliance. Reliability in the shaft is of course very essential. It is assured by the use of S. S. WHITE Shafts.

S.S.WHITE Flexible Shafts make devices like this practicable

This housewife is happy with her WIFE-SAVER, product of the Speedway Mfg. Co. of Cicero, Ill. It's so neat and simple and takes the drudgery out of so many kitchen tasks.

Best of all, it never gives her any trouble. The manufacturer made sure of that by equipping the WIFE-SAVER with S. S. WHITE Flexible Shafts,—shafts that have long been noted for their high quality and unfailing reliability.

The WIFE-SAVER is only one of many recently developed machines and devices which the reliability of S. S. WHITE Shafts has made practicable. More and more, designers and manufacturers are beginning to realize the possibilities of flexible shafts and are capitalizing on them.

Read the partial list of existing applications of S. S. WHITE Shafts. It will give you some idea of the broad scope of possibilities and will undoubtedly suggest many other desirable applications for which the flexible shaft is ideally suited.

Standard S. S. WHITE Drive Shafts ranging from the light .041" size to the powerful 3/4" diam. shaft, together with a wide variety of couplings and casings, meet the requirements of practically any application. At the same time the Company is equipped and prepared to make special shafts to suit specific requirements.

Complete data on S. S. WHITE Shafts will be furnished on request. Full and capable engineering co-operation is also offered for the working out of any unusual application. Inquiries are invited. Address them to

Partial List of Applications S. S. WHITE FLEXIBLE SHAFT

Machines

Valve Grinding
Screw Slotting
Milling
Glass Cutting
Testing
Portable Grinding
Concrete Surfacing
Paint Scraping
Floor Scraping
Engraving
Shoe Making
Animal Shearing
Hair Clipping
Massaging
Washing
Linotype
Printing Presses
Jewelers' Lathes
Surgical Engines
Dental Engines

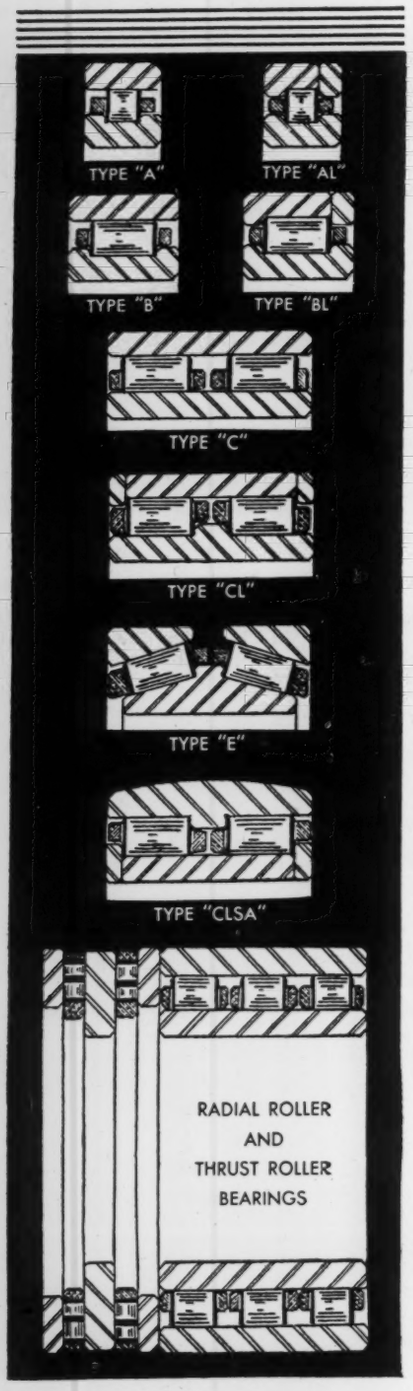
Miscellaneous

Aircraft Radio
Automobile Radio
Boiler Tube Cleaners
Tachometers
Speedometers
Counting Attachments
Taximeters
Indicators
Moving Picture Cameras & Projectors
Odometers
Gun Fire Controls
Valve Controls
Searchlight Controls
Engine Governors
Windshield Cleaners

The S.S.WHITE Dental Mfg. Co.
INDUSTRIAL DIVISION

154 West 42nd Street,
New York, N. Y.

BEARING SPECIALISTS FOR 32 YEARS



BANTAM offers you the benefit of 32 years' experience in the design and manufacture of dependable bearings for every industrial need.

The outstanding success of Bantam Bearings in heavy duty service has resulted in widespread demand for organized data on Bantam types and sizes. Prompted by this demand, Bantam engineers have evolved a ***series of standard sizes*** of roller bearings for heavy duty applications. A request will bring you both a Bantam engineer and a copy of this data.

Trade Mark Reg.

THE BANTAM BALL BEARING COMPANY

3600 West Sample Street
SOUTH BEND, INDIANA

NEW YORK
DETROIT
CHICAGO
CLEVELAND
PHILADELPHIA
ST. LOUIS
INDIANAPOLIS

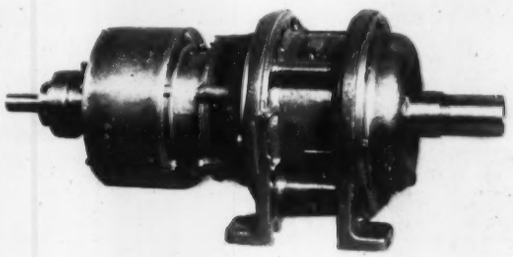
ONE OR A MILLION · · ½" TO 48" · ·

ively excludes dirt and other abrasive materials, retains lubrication and prevents leakage.

The new stock units are self-aligning. Because of the exclusive concave roller-convex raceway assembly, the bearing carries full load and rolls freely even at the extremes of its self-aligning action. This action eliminates difficulties frequently experienced where operating conditions are severe or where shaft deflection or misalignment is present.

Transmission Has Infinite Variations

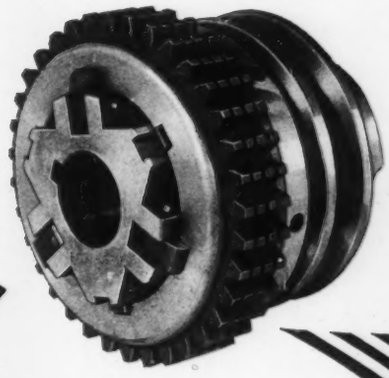
AN INFINITE number of output shaft speeds from 0 to 0.234 times the input shaft speed are available with the variable speed transmission developed by Weiss Engineering Corp., New York. The unit, shown in connection with a motor, consists of a rotating, or more strictly, nutating element which is carried on ball bearings over the surface of the inside of the casing which is hardened and ground to a true spherical shape. This element is connected to the output shaft by a rolling ball universal joint that operates with a constant angular velocity up to a maximum angle of 40 degrees. Torque applied at the driven shaft tends to force the ball bearings radially against the spherical surface. A connection between the input shaft and the



Unique construction permits infinite variations of output shaft speeds

nutating element is made by a splined shaft connected through a double link to a sleeve on a short shaft extension from the nutating element.

The splined shaft may be moved endwise by a control lever and will thus cause the nutating element to make an angle with the vertical. When the element is vertical, the axis of the input shaft and that of the element are in alignment and the output element remains stationary when the input shaft is rotated as the sleeve simply revolves on its shaft. When the element is shifted away from the vertical, it begins to nutate and rotate, and transmits power to the output shaft, the amount of this power depending directly upon the angle of the axis of the element with the vertical.



Single "CC" type Twin Disc Clutch, with compressed asbestos, gear tooth driving plates used when clutch runs dry.

. . . EASY CONTROL . . . . . .

STARTING AND STOPPING IS ALMOST INSTANTANEOUS

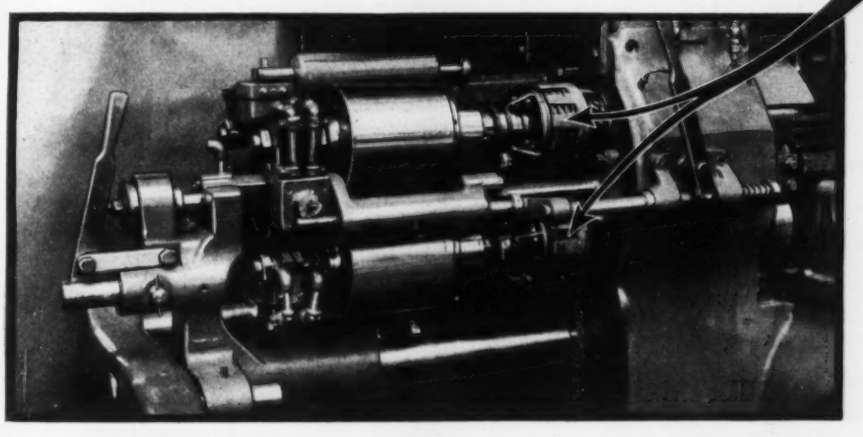
RAPID roughing and accurate finishing of castings, forgings, stampings, bar stocks, etc. is the job of the Model "H" Gridley Four Spindle Automatic Chucking Machine . . . and it has been designed "from the ground floor up" to do it.

Spindle control . . . the National Acme Company's designers decided . . . could be handled best by a Twin Disc, dry plate type, Machine Tool Clutch. No chance for sticking . . . and one or two spindles can be stopped instantly in any of four positions.

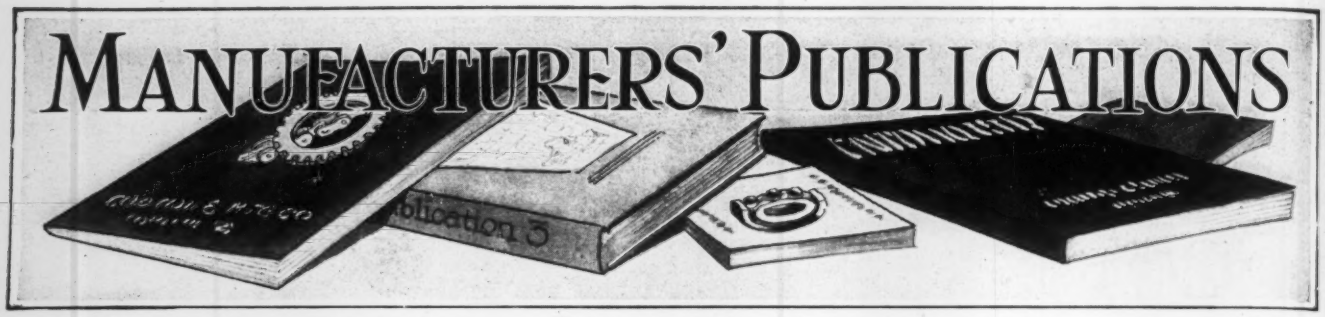
More and more machine designers are solving the control problem with the Twin Disc Machine Tool Clutch. It combines capacity with compactness . . . smoothness of performance with greater adaptability . . . and it meets modern methods of design with sizes and types for practically all machine tool requirements. 2, 2½, 3, 3½, 4, 4½, 5, 5½, 6, 7 and 9 inches effective diameters; single or duplex; oil or dry plate.

Write for Engineering Data Book. Specific recommendations gladly furnished by our Engineering Research Dep't. on request. *Twin Disc Clutch Company, 1325 Racine St., Racine, Wisconsin.*

TWIN DISC
CLUTCHES



MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS—Cooper Alloy Foundry Co., Elizabeth, N. J., has issued a pocket-size chart for corrosion and heat resisting alloy castings. It contains analyses, physical properties, uses, and other engineering data.

ALLOYS (IRON)—Chrome and nickel chrome iron alloys are presented in a recent publication of Superior Steel Corp., Pittsburgh. The booklet gives a systematic view of the different brands of rustless iron manufactured by the company including chemical and physical properties, corrosion resistance, scaling resistance, machining and typical applications.

ALLOYS (STEEL)—Driver-Harris Co., Harrison, N. J., has issued a booklet which presents photographs of some of the widely varying installations in which "Nichrome" castings and sheet containers have been used.

ALLOYS (STEEL)—Republic Steel Corp., Youngstown, O., in an illustrated booklet presents a wealth of data in convenient chart form on alloy steels, with information on heat treatment of these steels.

BEARINGS—An entirely new line of roller bearing units for normal duty including pillow blocks, flange units, and take-up units containing extended inner race, double row self-aligning roller bearings are described in a recent folder issued by Shafer Bearing Corp., Chicago, which gives dimensions and prices.

BEARINGS—A compilation of standard sizes of bearings for heavy duty service has been announced by Bantam Ball Bearing Co., South Bend, Ind. The series, said to be the first of its kind, comprises an organized progression of sizes of roller bearings for rolling mill, paper mill, rubber mill, printing press, super-calendar, rock crusher, mining machinery and other such applications.

CONTROLS—Time cycle contactors adaptable to a wide variety of industrial processes are described in bulletin 1212 issued by Automatic Temperature Control Co. Inc., Philadelphia. Manually operated cycle stop types, semi-automatic cycle stop types, automatic cycle repeating types, and cycle program types are included in the booklet which also gives wiring diagrams and engineering tables.

CONVEYOR BELTS—Diamond Rubber Co. Inc., Akron, has issued a booklet of correct practice for conveyor belts. The booklet includes tables of permissible loads and similar engineering data.

DRIVES—Indestructible welded steel speed reducers housings introduced as standard equipment by Philadelphia Gear Works, Philadelphia, are described in a new pamphlet issued by the company.

DRIVES—Crocker-Wheeler Electric Mfg. Co., Ampere, N. J., has prepared bulletin No. 233 which describes the types "C" and "S" speed reducers and speed increasers manufactured by the company. This equipment is the adhesion type of speed changer developed by C. G. Garrard.

FASTENINGS—The Marsden Locknut, an ordinary nut having a slotted head and a dished or recessed bottom, is described in a bulletin prepared by American Marsden Co., Jersey City, N. J.

ELECTRICAL EQUIPMENT—The switch and panel division, Square D Co., Detroit, has just published a new bulletin, No. CA505A, describing its new shallow type safety panelboard.

LUBRICATING EQUIPMENT—A booklet describing the new Farval type "C" automatic system of lubrication which is controlled by the operation of the machine on which it is installed has been prepared by Lubrication Devices Inc., Battle Creek, Mich.

METALS—Fansteel Products Co. Inc., North Chicago, Ill., has brought out an attractive illustrated booklet giving the history, properties and uses of rare metals. The metals included in this 1931 edition of the booklet are tantalum, tungsten, molybdenum, caesium, rubidium and columbium.

MOTORS—Ideal Electric & Mfg. Co., Mansfield, O., has issued a new bulletin, No. 520, on synchronous motors. Descriptive matter, application data and dimension charts are given covering the flywheel type synchronous motor and six other standard types. Many installations illustrate the bulletin.

PUMPS—Worthington Pump & Machinery Corp., Harrison, N. J., has issued a booklet on its Type D (Monobloc) centrifugal pumps. The booklet includes a description, rating tables, a table of pump combinations with motor characteristics, and a dimension table.

PUMPS—Oilgear Co., Milwaukee, has issued two bulletins describing new pumps manufactured by the company. Bulletin 42210 gives the specifications of the type QR-2 one way variable delivery pump; bulletin 42226 gives specifications of the type QWR-2 one way variable delivery pump which has constant and variable pressure control. Applications in which these pumps may be used also are included.

WELDED PARTS—Bonney Forge & Tool Works, Allentown, Pa., has issued a booklet describing its drop forged pipe outlets for use in welding. These outlets, which are easily and quickly installed, are manufactured in two types, "Weldolets" for use where both connections are to be welded, and "Threadolets" which may be welded to the pipe and have a thread connection for the incoming pipe.

QUIET

at 3450 R. P. M.

...with Fafnirs supporting the shafts of Ray Oil Burners

QUIETNESS at such high speeds bespeaks exceptional engineering . . . and exceptional bearings. Ray engineers designed a burner shaft assembly so carefully centered and balanced that it could be stopped at any point in a revolution . . . and stand stock still! Then they picked Fafnirs to preserve this balance in hard service.

Fafnirs were given the job because they are made to ultra-precision standards, and because their precision is protected by tough, wear-resisting alloy steel that maintains rigid alignment and keeps the bearing from "wearing noisy". All loads, all speeds find ample capacity in Fafnirs' maximum complement of maximum-diameter balls, rolling friction-free in their deep raceways.

So it is that Fafnirs are important factors in the long life and low maintenance cost of all Ray Oil Burners. Wherever precision must be protected, it pays to fortify with Fafnirs.

THE FAFNIR BEARING COMPANY, NEW BRITAIN, CONNECTICUT

Atanta, Chicago, Cincinnati, Cleveland, Dallas, Detroit,
Los Angeles, Newark, New York, Milwaukee, Philadelphia

FAFNIR MOST COMPLETE LINE OF PRECISION BALL BEARINGS IN U.S.A.

FAFNIR BALL BEARINGS